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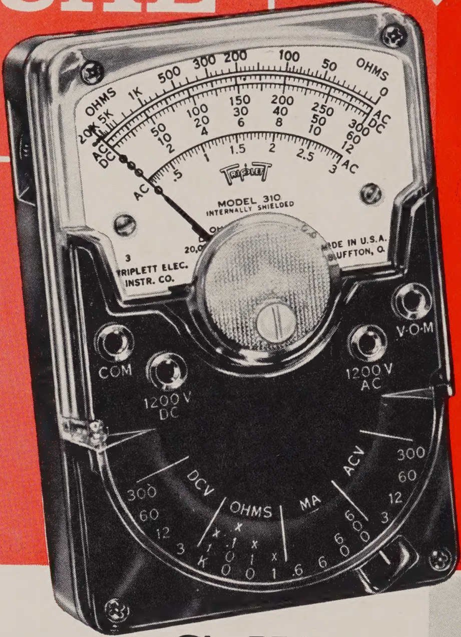

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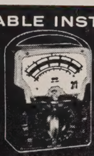
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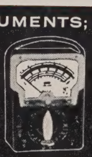
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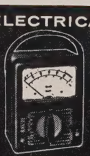
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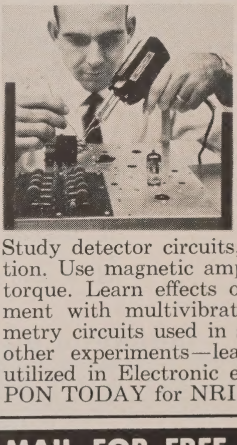

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(see page 35)

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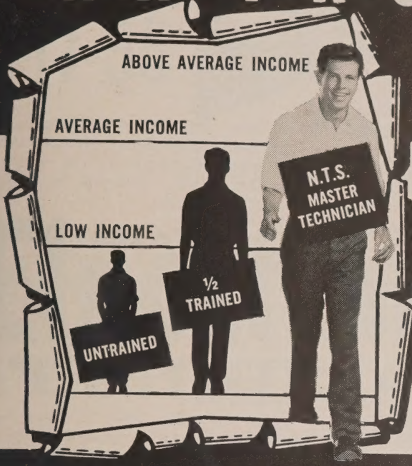

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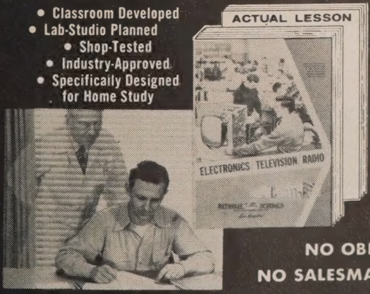

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News Briefs

TV Booster Deadline Extended by FCC

Unauthorized vhf TV booster stations, which were to have been legalized by Feb. 1, were given 2 months additional time making the deadline for filing translator applications April 1. Chief reason for the extension was the limited availability of type-accepted translator equipment in comparison with the large number of stations switching over to such apparatus. Over 1,000 booster stations had filed applications by the first week of February, and 950 had been given temporary operating permits. The FCC stated that it was hoped to have all booster stations operating legally by the end of October.

Scientific Burglary

Hand-held two-way radios were used by a gang of four men to rob a Chicago optical supplies concern. The four, keeping in touch with each other continuously, were able to organize the raid, speed the removal of the goods by a freight elevator, and get them into a waiting truck and away.

The story is reminiscent of similar robberies after the last war, when surplus military portable radio equipment was readily available. Possibly the large amount of Citizens-band equipment on the market was the inspiration this time.

New Optical Maser Works Continuously

Bell Laboratories have demonstrated an optical maser that operates continuously with an input power in the order of 100 watts. Like the pulsed optical maser (RADIO-ELECTRONICS, December 1960, page 8), it is a cylinder in which light waves travel longitudinally, building up amplitude as they go. Unlike the earlier maser, the cylinder in this one is a glass tube containing a mixture of helium and neon gas. When the gas is ionized (in this case by being excited from an external radio-frequency source), energy is transferred to the helium atoms, raising them to a higher energy state. As they collide with the neon atoms, they release this energy, exciting the neon atoms. As the neon atoms drop to a lower energy level, they release photons of light which travel down the tube, striking more neon atoms and releasing still more light. At the ends of the tubes, very thin mirrors reflect at least 95% of the light again through the tube to the other end, where it is again reflected. In its passages through the tube, the light is continuously releasing more light from excited neon atoms. Each photon that joins the others in the trip up and down the tube adds to the amplification. Those that start in other directions pass through the sides of the tube and are lost. A small portion of the light escaping through the end mirrors provides the beam used for communication.

At the demonstration, telephone announcements were transmitted on the maser beam to a photocell some 30 feet away, where it was demodulated for listeners. An even more interesting demonstration was that of heterodyning two light frequencies to produce a beat note in the radio spectrum, which was detected by a radio receiver and exhibited on a scope.

The output is in the deep infrared, between 9,000 and 17,000 Angstroms. Bell scientists envision optical beams at these frequencies carrying fantastic numbers of phone conversations—or even TV programs—as compared to the number possible on present microwave links.

Uhf Dx'ers Win Edison Award

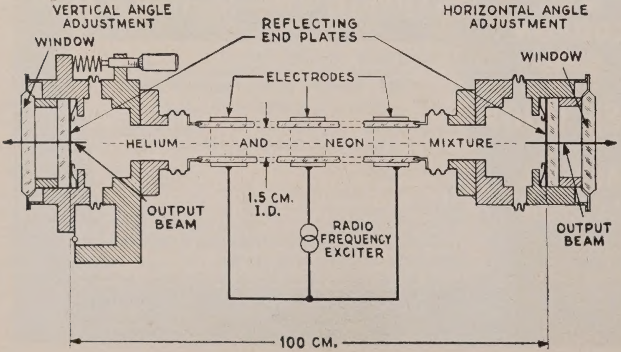
John T. Chambers, W6NLZ, and Ralph E. Thomas, KH6UK, have been awarded General Electric's Edison Radio Amateur Award for this year. The two hams conducted transmission and reception tests that "opened new horizons in uhf communications."

On July 20, 1960, the two hams set a one-way communications distance record of 2,540 miles on 432 mc, between W6NLZ's station near Los Angeles, Calif., and KH6UK's in Oahu, Hawaii. The previously unheard-of records were made by using tropospheric ducting, or natural waveguides in the atmosphere. The achievement was the result of 4 years of work and experimenting, and followed earlier records of communication over the same distance on 144 and 220 mc.

The panel of judges, consisting of Rosel Hyde of the FCC, Robert C. Edson of the American National Red Cross, and F. E. Handy of the ARRL, compared the accomplishment with the first amateur trans-Atlantic communications breakthrough in the 1920's. They pointed out that the feat had greatly enhanced the standing of ham operators in the scientific world.

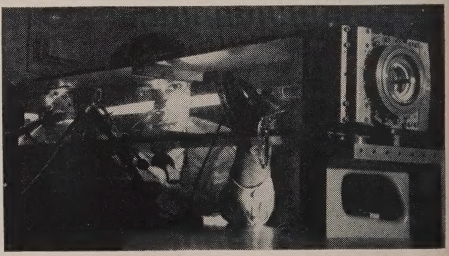
Local conditions give the two hams the clues they need to correct propagation periods.

Chambers keeps his weather eye on the Los Angeles smog. When it lies low over the area, with church spires and hilltops protruding from it into clear air above, Chambers has the



Simplified cross-section of the continuously operating maser.

Dr. Ali Javan of Bell Laboratories with the maser he invented.



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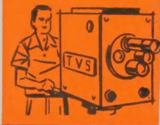

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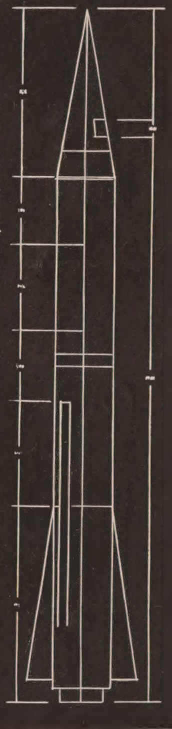

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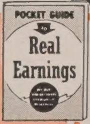

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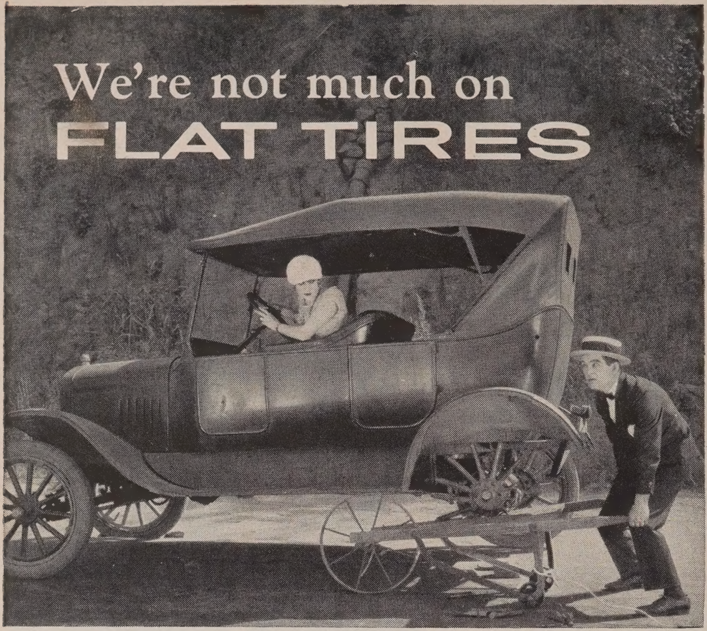

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sign he's looking for. The inversion of hot, dry air over the damp smog close to the ground indicates that tropospheric ducting is likely.

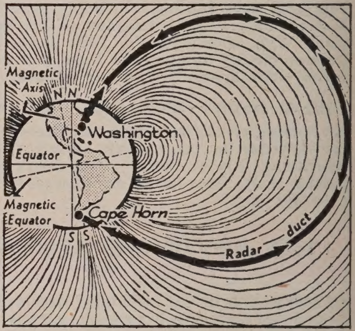
In Hawaii, Thomas keeps his eye on the evening sky, looking for low-hanging clouds with flat tops. When conditions are right in both Hawaii and California, tropospheric propagation of uhf signals is likely and the hams go to work.

The award, a trophy and prize of $500, has been awarded annually for the last 9 years. This year is the first time it has been granted jointly to two amateurs, and the first time for a scientific achievement.

Six other US hams were cited for outstanding public service: Harry E. Phillips, W7CKV, Tucson, Ariz.; Donald Johnson, W6QIE, San Francisco; Francis E. Ireland, K4UUO, Miami, Fla.; Albert W. Parker, New Bern, S.C.; Cesare P. Cavadini, W6GYH, Burbank, Calif., and Edwin S. Van Deusen, W3ECP, Washington, D. C. In addition, a special commendation was voted to Mario Lagos, CE7BC, Chiloe Island, Chile. Though CE7BC was outside the scope of the award, as a nonresident of the United States, his handling of 3,744 official and welfare messages during his country's earthquake last summer was deemed worthy of special recognition.

Earth Has Magnetic Waveguides

Recently discovered ducts in space surrounding the earth can bend radar beams, channeling them in a near-circular path back to the earth in the opposite hemisphere. A radar beam aimed at a carefully selected point in the sky produces an echo that could have come only from a point near the southern tip of South America.



The ducts follow the lines of the earth's magnetic field, and are thought to be composed of electrons strung out in thin fiberlike patterns along the lines of force of the earth's field. The signal follows these threads of electrons.

The ducts were discovered by Dr. Roger Gallet, of the Bureau of Standards laboratory in Boulder, Colo. To test his theory, radar pulses

(*Continued on page* 18)

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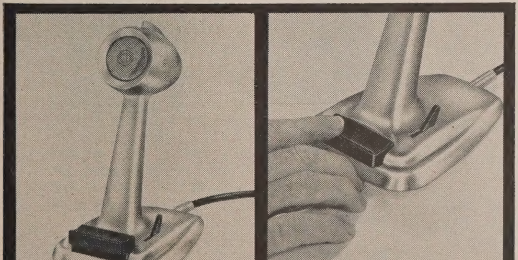

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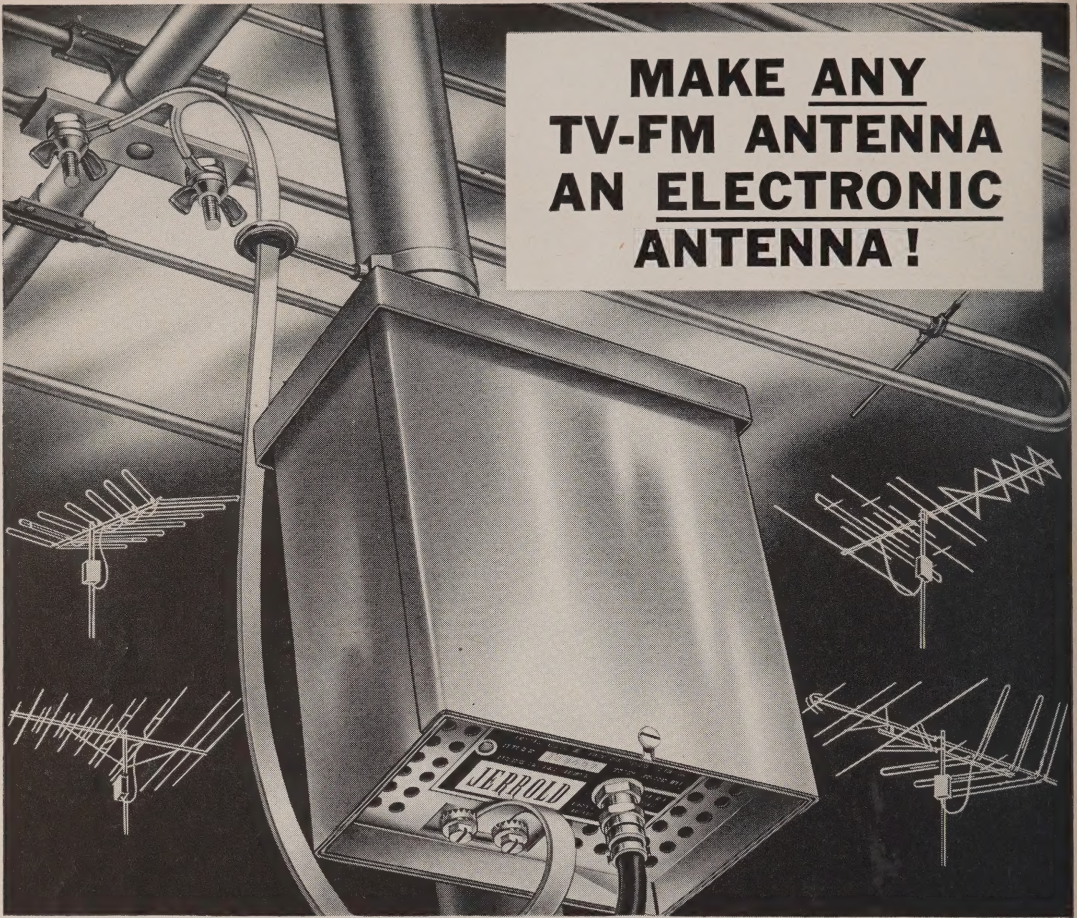


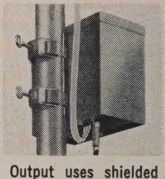
New Jerrold DE-SNOWER® Model 202
Increases Gain of Any Antenna 10 TIMES!

Out of the Jerrold laboratories, where the famous DSA-132 was born, comes the ultimate in signal preamplifiers for all channel TV (VHF) and FM reception. By combining *two* frame grid 6DJ8 dual triodes in a special low noise circuit, Jerrold's new DSA-202 develops *minimum* 20 db gain (10 times) on all TV channels and 8db (min.) on FM . . . *triple* the gain developed when using one 6DJ8. Also featured is a new lightweight iridite-aluminum weather-proof housing; no-strip twin lead terminals; and sliding access panel. All new high output remote power supply reduces a 117v AC to a safe 22 volts which goes up same cable that amplified signal comes down.

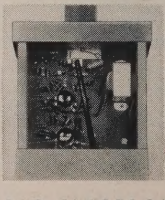
Only Jerrold assures you of proven reliability and unequaled performance based on more than a decade of designing and producing mast mounted preamplifiers . . . more Jerrold De-Snowers are in use today than all other makes combined.

See your Jerrold distributor or write for eight page booklet No. 435-286

Includes new power supply model 407-P. Has "on-off" switch and handy cable compensating control.


Output uses shielded coax. to eliminate antenna feed-back and interference pick-up on down-lead.

Two 6DJ8 tubes develop 20 db gain (minimum) on all TV (VHF) and FM channels. →



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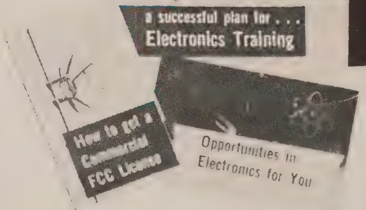
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Cleveland Institute of Electronics

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RE52B

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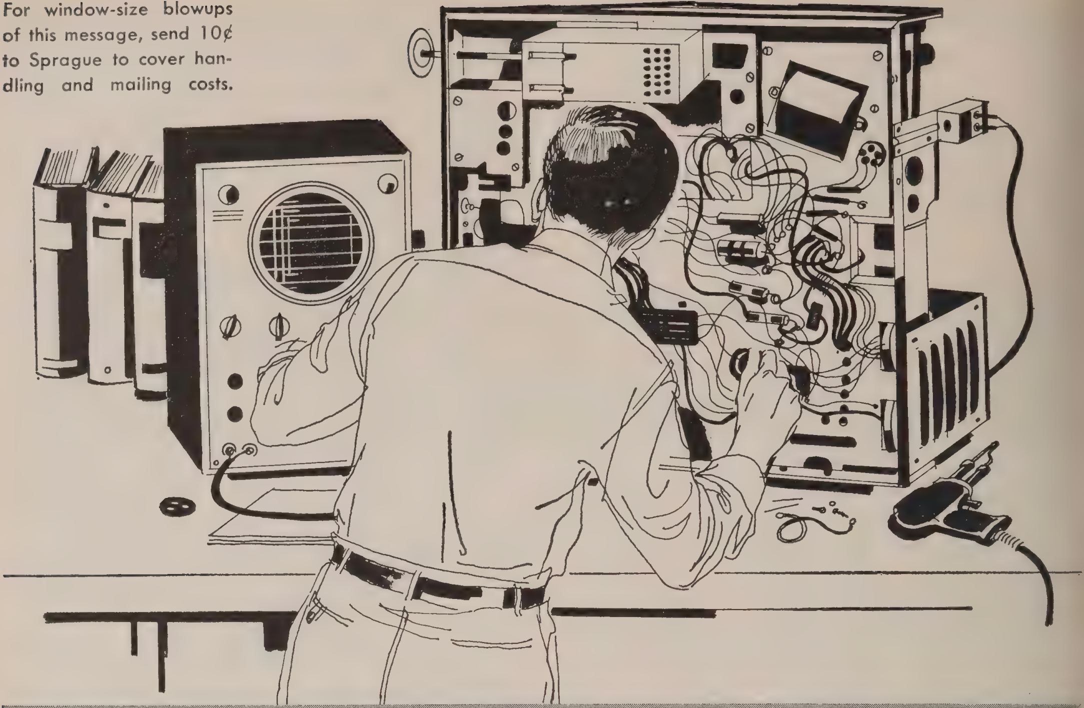

More than 5600 ft. of circuitry . . . 590 parts . . . and he has to know how to fix 'em all!

YOUR TV SET is the most complicated piece of equipment you've ever owned. It represents a considerable investment of money. It provides your family with a wealth of entertainment pleasure. You value it highly.

Nobody is more aware of these facts than your neighborhood TV-Radio technician. And because he stakes his reputation on your satisfaction, *he strives to be worthy of your trust in him.* He achieves this by years of training and practice in electronic theory and application. He equips himself with expensive but essential test equipment, tools, and service manuals. He spends countless hours keeping up-to-date on new developments, new circuits, new trouble-shooting techniques.

His training and experience qualify him as a modern, professional expert. As such, he asks a fair, professional price for his services. Since he will not use cut-rate methods or cut-rate parts in your TV set, he cannot offer cut-rate prices. *Remember, you get only your money's worth in TV-Radio service. When you are taken in by a "bargain-type" offer, you can expect to get "bargain-type" service. BEWARE THE SERVICE BARGAIN!*

THIS MESSAGE WAS PREPARED BY SPRAGUE PRODUCTS COMPANY,

DISTRIBUTORS' SUPPLY SUBSIDIARY OF SPRAGUE ELECTRIC CO., NORTH ADAMS, MASS., FOR

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This CREI program in Electronics Engineering Technology may be completed in 2 to 4 years, depending on how much of your spare time you can devote to study. The courses are presented in easy-to-understand form. Our instructors will give you personal attention and assist you when you need help.

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There is a drastic need in the electronics industry for well-educated engineers and technical personnel. Although the great majority of students find ample opportunity for advancement with their present companies, CREI maintains a Placement Bureau to assist graduates and advanced students in finding more desirable positions. For many years, the demand for CREI graduates and advanced students has far exceeded the supply.

• • • • • •

Regularly across my desk, comes evidence that CREI's advanced Home Study Program in Electronics has provided an answer both for industry and for far-sighted men, who want to rise to higher levels of achievement. This evidence takes the form of letters from industry leaders and CREI graduates, who express their appreciation for the program and its value in their industry. These letters also state that advancements for CREI men are frequent and extensive. The CREI graduate may enjoy the benefits of new recognition, superior status and higher earnings as a result of his college-level electronics education.

E. H. Rietzke, President
Capitol Radio Engineering Institute

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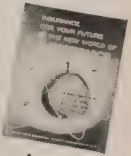

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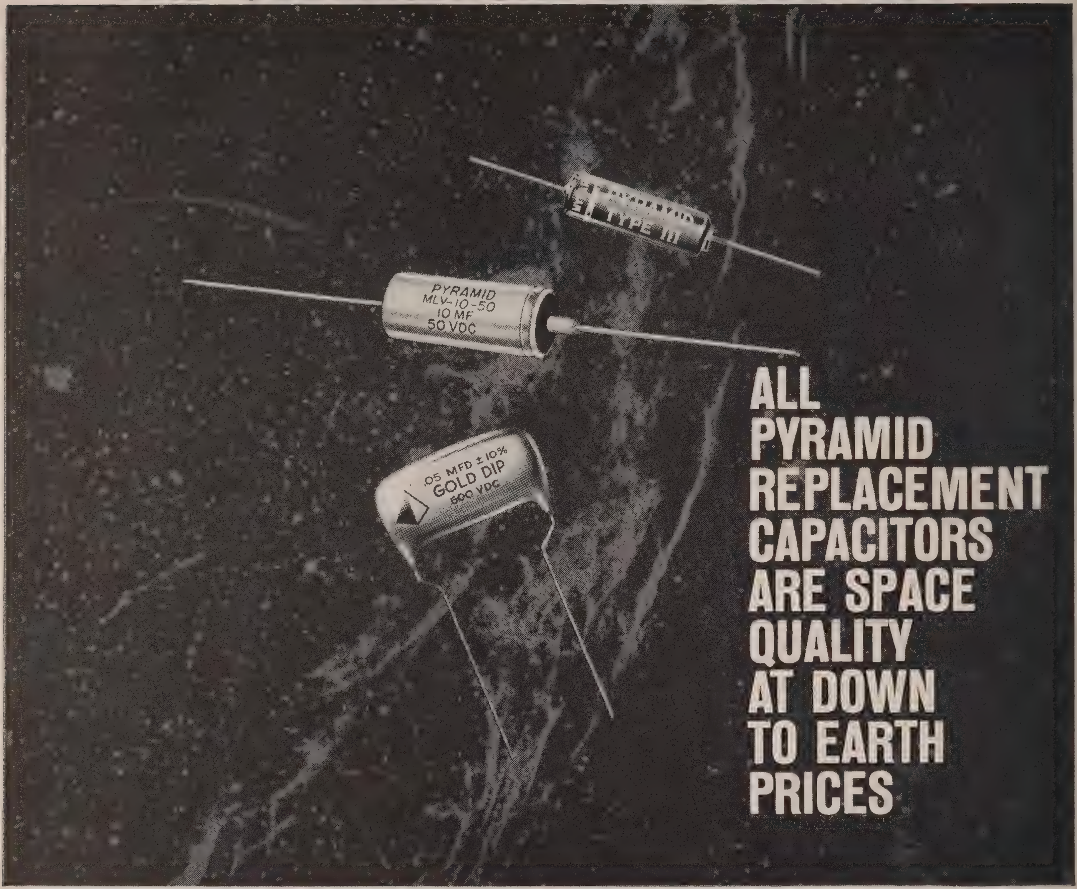
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Type 111 "Gold Standard" Molded Mylar Capacitors are now available in greatly reduced sizes. They have a noninductive polyester film extended foil section, and are molded in a noninflammable thermosetting plastic case. These capacitors have very high insulation resistance, are impervious to moisture and are extremely rugged.

Operating temperature range: −55°C to +100°C.

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MLV Miniature Electrolytic Capacitors are ideally suited for transistorized radio receivers, hearing aids, portable TV sets, and miniaturized circuit requirements. These capacitors are noted for low leakage and a long shelf and operating life. They are designed for 85°C operation.

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Type 151 Gold-Dip Mylar capacitors are designed to be used for printed board circuitry as well as conventional applications. They are engineered for the highest reliability, are moisture resistant and have high insulation resistance.

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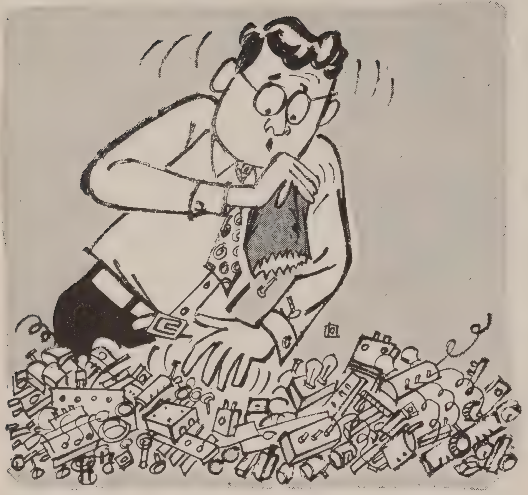
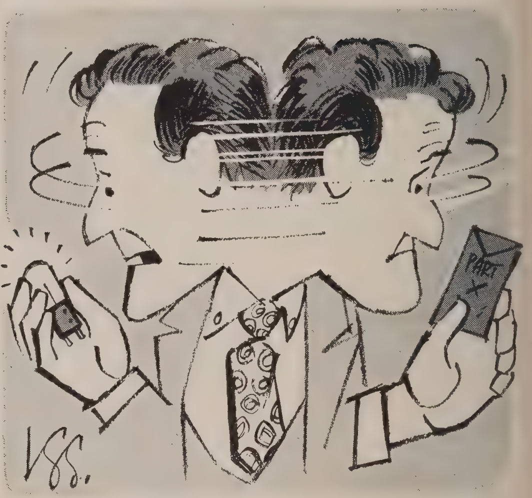
I am interested in: ☐ Home Study, ☐ Kansas City classes, 14D
☐ Hollywood classes, ☐ Seattle classes, ☐ Washington classes

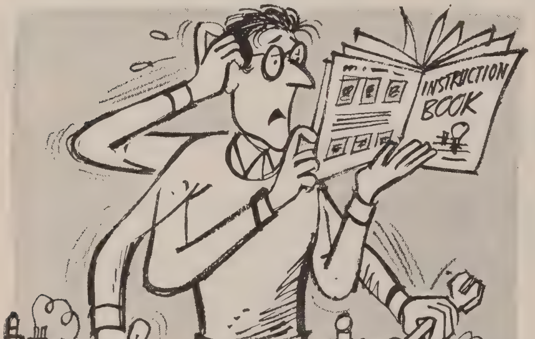
IT COULD HAPPEN TO YOU...



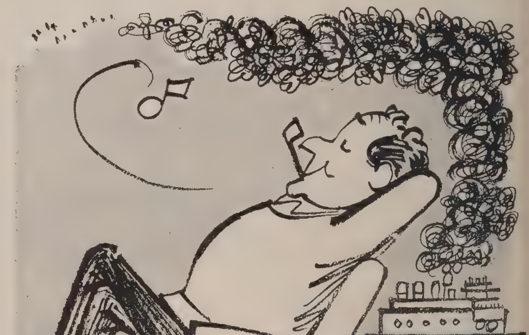
Somewhere it said: "Build this kit in an amazing 10 hours!" Looks like you're running into overtime because you spent the first 7½ hours sorting out the jumbled mess of small parts and hardware. Well, it's good training for looking for needles in haystacks.



If drug manufacturers made the mistakes in labeling you find in some kits, the world would be a quieter, lonelier place. You know a selenium rectifier when you see one, and if this is a selenium rectifier, you're Thomas Alva Edison.

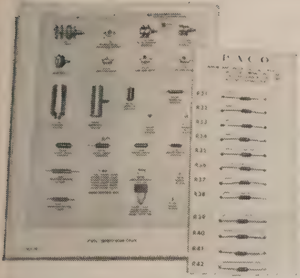


Let's see. On Page 5 it says; "See diagram Page 12." On Page 12 it says; "See instructions Page 5." Well, if you hold Page 5 open with your tongue, and Page 12 open with your left ear, that still leaves you three fingers on your left hand free for soldering and also...

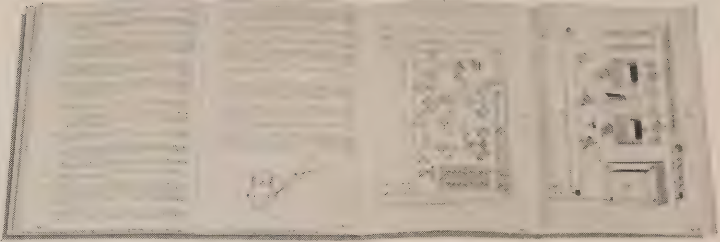


Don't look now, but while Heifetz fiddles, your amplifier burns. When the smoke clears, you'll probably find that the 100 microfarad electrolytic was shorted because it had not been pre-tested. All work and no play, makes Jack a very mad boy!

UNLESS THE KIT YOU BUILD IS A PACO



No mistaken identity or endless searching. Parts are clearly pictured and labeled; resistors are neatly mounted and identified!



Step-by-step instruction book makes assembling a Paco Kit foolproof! Paco gives you giant, fold-out diagrams on corresponding instruction pages so you can see both at the same time.

PACO Model C-25
IN-CIRCUIT CAPACITOR TESTER KIT

Reveals dried out, shorted, or open electrolytics—in the circuit—with Paco's exclusive Capacity Dial. Instantly finds open or direct shorted capacitors without removing from circuit. Great time saver!

Specifications:

SIMPLE SEQUENTIAL TEST: reveals open or shorted capacitors, including electrolytic types.

ELECTROLYTIC DIAL: indicates actual electrolytic values while capacitor is in-circuit; any electrolytic which yields a capacity reading on Electrolytic Dial is automatically revealed as not open or shorted.

ELECTROLYTIC TEST: indicates in-circuit electrolytic capacity from 2 mfd to 400 mfd in two ranges; condenser is automatically proved non-shorted and not open if Capacity Reading can be obtained.

Model C-25: Kit, complete with PACO-detailed assembly-operating manual. **Kit Net Price: $19.95**

Model C-25W: Factory-wired, ready to operate. **Net Price: 29.95**

PACO Model DF-90
TRANSISTORIZED DEPTH FINDER KIT

Protect your boat against shoals and underwater hazards with this compact, easy-to-read depth finder. Transistors prolong battery life, provide utmost accuracy and portability. A boon to fishermen—locates hard-to-find schools of fish. A low cost safety device for every boat owner.

Specifications:

FULLY TRANSISTORIZED: 5 transistors, with a low battery drain for extremely long battery life.

HIGH INTENSITY INDICATOR: for sensitive, accurate response under all conditions.

FAST, EASY READINGS: made possible by means of over-sized scale calibrated at one-foot intervals from 0 to 120 feet.

Model DF-90: Kit, complete with PACO-detailed assembly-operating manual. **Kit Net Price: $84.50**

Model DF-90W: Factory-wired, ready to operate. **Net Price: $135.50**

PACO Model SA-40
STEREO PREAMP-AMPLIFIER KIT

Assemble a superb home music system with this true 40 watt stereo preamp-amplifier. Unmatched flexibility, less than 0.5% distortion, and handsome design make this the ideal component for music lover and audiophile alike!

Specifications:

MUSIC WAVEFORM POWER OUTPUT: 25 watts per channel (50 watts total).

RESPONSE: 30 cps to 90Kc, ± 1.0% db

HARMONIC DISTORTION: less than 0.5% at 20 watts per channel output.

Model SA-40: Kit, complete with black and gold case and PACO-detailed assembly-operating manual.................**Kit Net Price: $79.95**

Model SA-40W: Factory-wired, with black and gold case, ready to operate. **Net Price: $129.95**

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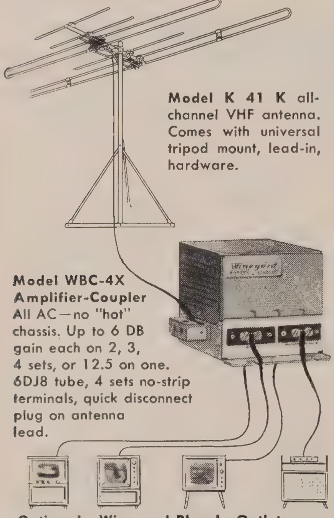

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Model WBC-4X Amplifier-Coupler All AC—no "hot" chassis. Up to 6 DB gain each on 2, 3, 4 sets, or 12.5 on one. 6DJ8 tube, 4 sets no-strip terminals, quick disconnect plug on antenna lead.

Optional—Winegard Plug-In Outlets, surface or flush mount as low as $2.10 each.

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Everything from antenna to set

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ANTENNA SYSTEMS

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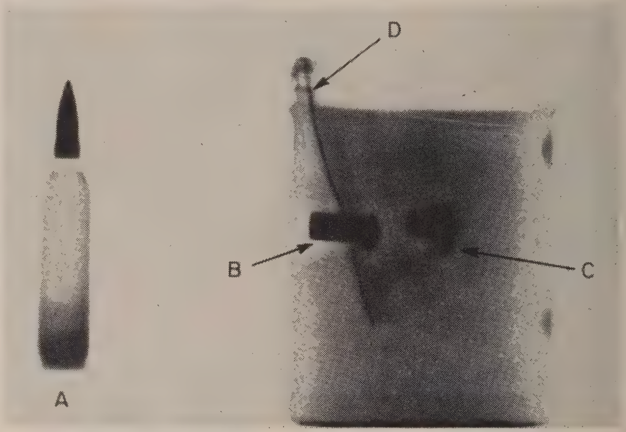
(*Continued from page* 8)

directed at a point 71° above the horizon at Washington, D. C., echoed back from a distance of 30,000 miles, presumably from a point near Cape Horn.

New Tube Speeds X-ray Photos

A new pulsed X-ray system makes X-ray pictures of as short an exposure as 1 microsecond possible, scientists of Zenith Radio Research Corp. announce. The most important component of the system is an oxide-coated hot-cathode X-ray tube capable of conducting high currents at high voltage with fast rise-time characteristics. The life of the new tube is expected to exceed 1,000,000 shots. Earlier high-intensity X-ray tubes were limited to a life of a few hundred shots and could be pulsed only once every several minutes.



A square-wave voltage pulse of 1 μsec duration is applied to the tube. The voltage is variable up to 150 kv. With a beam current of 130 amperes and 150 kv, an electron beam of approximately 20 megawatts is focused on the tube's target (anode), producing X-rays that have an effective spot size of 1 x 2 mm, and an intensity rate of 10^7 Roentgens per second at 1 inch from the target.

The photograph shows two exposures of a bullet moving at 4,000 feet per second, taken 25 μsec apart. The bullet, shown in its cartridge at A, is just entering an aluminum salt shaker filled with water at B. C is an X-ray picture of the bullet inside the can and shows flattening of the nose and mushrooming. (D is the trigger wire that initiated the series of pictures.)

Supermagnets Possible With New Alloy

Scientists at Bell Telephone Labs have announced that a new superconducting compound of niobium and tin (Nb_3Sn) and a special technique of drawing the metal into wire can be used to construct magnets of fantastic strength which will use very little power. Some very large magnets are used in nuclear research and similar purposes. The one at the Bell Telephone Murray Hill (N. J.) laboratory, for example, requires a power supply and cooling equipment that fills several rooms. Thousands of gallons of water per hour are needed to cool it, and it requires 1.5 megawatts of electric power; 25% of the total power consumed by the whole laboratory, which employs 4,500 people. With the new material, negligible power would be required once the field had been set up.

The niobium-tin compound operates at superconducting temperatures (18° Kelvin or lower) at which temperatures it can carry almost unlimited amounts of current. The difficulty is that a magnetic field destroys superconductivity. The tin-niobium compound is unique in that it remains superconductive at much higher field strengths than any other material. (It also remains superconductive at much higher temperatures.)

Offsetting this advantage was the disadvantage that the compound is too brittle to be made into wire. The scientists solved this problem by packing powdered niobium and tin mixed in the proper proportion into thin tubes of niobium, which is relatively ductile. These tubes were drawn to the requisite thinness and wound into coils. Then the coils were heated to 1,000°C, when the powders fused to form the compound. Wire so made can carry currents of over 150,000 amperes per square centimeter, and remain superconducting in fields of 88,000 gauss. Though not yet tested, it is believed these properties will extend to fields of 100,000 gauss and possibly higher.

Entertainment Wall For New Apartments

Plans now under way would equip each of 900 deluxe Chicago apartments with an entertainment wall, to contain AM and FM radio, stereo

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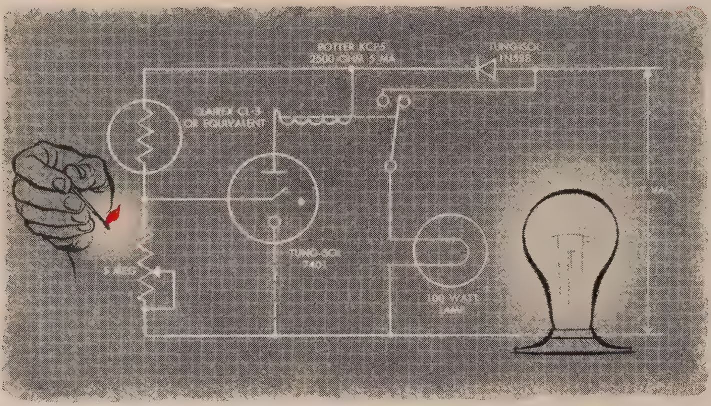
Latest issue of

TUNG-SOL TIPS

tells you what you should know about

INDICATOR THYRATRONS



TRICK CIRCUIT. This is a fascinating easy-to-build circuit that makes "magical" use of the Tung-Sol 7401 indicator thyratron. By merely striking a match in the vicinity of the cadmium sulfide cell (designated by the Clairex CL-3), you can make the 100 watt lamp glow. There are no switches to throw. It's used to demonstrate some interesting aspects of indicator thyratron operation and it's discussed in this latest illuminating issue of Tung-Sol Tips.

BRIEFLY and simply, electronic indicators allow us to determine visually when they are in a conducting state. That is, when we see them glow we know they're conducting. It's just as simple as that. And for this reason these indicating devices play an important role in much of today's electronic equipment. However, there's more to them than meets the eye. So Tung-Sol has devoted the latest issue of *Tung-Sol Tips* to a discussion of these versatile gadgets.

This fast and bright reading Issue #16 was especially written for the industrial serviceman by a top designer of indicator thyratrons. Calling upon his solid background and long experience, the author very carefully differentiates between many kinds of devices used for indication. He cites their advantages and the applications where each is most efficient, in a presentation that is always lucid and to the point. Moreover, he has included an interesting historical description of other indicating devices which have been in common use since Thomas A. Edison's time.

This is the kind of comprehensive round-up you won't want to miss if industrial servicing is your business. And there's no reason to, because *Tips* is free and easy to get. Just drop in to your nearest Tung-Sol distributor and ask him to put you on the Tung-Sol Tips mailing list. Otherwise, mail your request directly to Tung-Sol and begin getting your issues of *Tips* regularly every month. Tung-Sol Electric Inc., Newark 4, N. J.

Missing Back Issues?

If you're already a *Tips* subscriber, but you find your library is not complete, you can still get any of the preceding fourteen issues to bring you up-to-date. Just mail your request to Tung-Sol, telling us which issues you require.

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IN CANADA: ABBEY ELECTRONICS, TORONTO, ONT.

hi-fi and a 4½ x 6-foot projection TV, according to *Television Digest*. The apartments would be opened in 1962.

The wall TV equipment would be a new type, developed by Dalto Electranics of Norwood, N. J. It uses rear-screen projection with a new projection tube called the Amphicon. It is a flat 5-inch tube with 40,000 volts on the ultor. Unlike most projection systems, it abandons the Schmidt optical system. The optics are the same as those for home slide projectors, as is the method of focusing. List price is about $1,950, making it more suitable for installation in new buildings where the cost can be amortized over a period of years than for over-the-counter sale.

Calendar of Events

IHFM High Fidelity Music Show, April 4–9, Ambassador Hotel, Los Angeles, Calif.

American Society for Testing Materials Symposium on Materials and Electron Device Processing, April 5–7, Benjamin Franklin Hotel, Philadelphia, Pa.

Southwestern IRE Conference & Electronics Show, April 19–21, Baker Hotel and Dallas Memorial Coliseum, Dallas, Tex.

IRE 7th Region Technical Conference and Trade Show, April 26–28, Westward Ho Hotel, Phoenix, Ariz.

IRE Electronic Components Conference, May 2–4, Jack Tar Hotel, San Francisco, Calif.

IRE Symposium on Human Factors in Electronics, May 4–5, Marriott-Twin Bridges Motor Hotel, Arlington, Va.

IRE Midwest Symposium on Circuit Theory, May 8–9, Allerton Park & Urbana Campus, University of Illinois.

IRE National Aerospace Electronics Conference, May 8–10, Biltmore and Miami hotels, Dayton, Ohio.

IRE-AIEE Western Joint Computer Conference, May 9–11, Ambassador Hotel, Los Angeles, Calif.

IRE Microwave Theory & Techniques Symposium, May 15–17, Sheraton Park Hotel, Washington, D.C.

IRE-AIEE Global Communications Symposium, May 22–24, Hotel Sherman, Chicago, Ill.

IRE-AIEE National Telemetering Conference, May 22–24, Sheraton Towers Hotel, Chicago, Ill.

1961 Electronic Parts Distributor Show, May 22–24, Conrad Hilton Hotel, Chicago, Ill. (Attendance limited to manufacturers and their advertising agencies, representatives and distributors) *Radio-Electronics* will exhibit in room 610.

EIA Annual Convention, May 24–26, Pick-Congress Hotel, Chicago, Ill.

British Radio and Electronic Component Manufacturers' Federation Show, May 30–June 2, Olympia, London, England.

IRE Meet March 20–23

The international convention of the Institute of Radio Engineers has been scheduled for the New York Coliseum in New York, N. Y., from Monday, March 20 through Thursday, March 23. A program of 275 papers deals with the most recent developments in the fields of all 28 IRE Professional Groups. There are 54 sessions, discussing subjects that range from ultrasonics to microwaves and from reactor instrumentation to human factors in electronics.

More than 850 manufacturers will show their new products at the exhibition which accompanies the IRE convention. Some $15,000,000 worth of equipment is expected to be on exhibition, most of it for the first time. END

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Correspondence

EFFECTS

Dear Editor:

I was interested in the article by J. H. Thomas in the February, 1961, issue of RADIO-ELECTRONICS, page 81, on the various effects. It was a good review for me. However, I disagree with the description of the Barkhausen effect. Looking into the matter further, I found the following:

> BARKHAUSEN EFFECT. Effect observed when a ferromagnetic substance is magnetized by a slowly increasing magnetic field; the magnetization does not take place continuously, but in a series of small steps. The effect is due to orientation of magnetic domains present in the substance.

This was taken from *A Dictionary of Science* by E. B. Uvarov and D. R. Chapman (Penguin Books, 1956).

I have been told that with a reasonably good amplifier one can hear the magnetic induction caused by flipping domains.

DONALD O. CHRISTY
Manhattan, Kans.

[You and Mr. Thomas appear to be saying the same things but using different words.—*Editor*]

AS THINGS GET SMALLER

Dear Editor:

Miniaturization has taken tremendous steps in many fields. There is a strong wish to miniaturize loudspeakers too. Here, however, as in radio antennas, the size of the radiator must be related to the wavelength to be radiated. Of course, by sacrificing efficiency, one may make a speaker smaller than the optimum but the distortion goes up with the reciprocal of efficiency, and even now we have speakers for which 100-watt amplifiers are recommended for acoustic power output in the order of .01 watt.

The half-wave dipole or its half-size equivalent of a quarter-wave rod with its mirror image represents efficient radiation. In the same way, a speaker must be of a size comparable to a half wavelength, or the equivalent of a quarter-wave with ground-plane reflections forming mirror images, to be an efficacious converter of electrical to acoustical energy. About the limit to be attained with the aid of mirror images is a speaker in the corner formed by three mutually perpendicular walls.

One can name a dozen or more speakers, each hailed as a "major breakthrough" at its introduction, which have risen and declined since 1948. Where are they now? The current

(*Continued on page* 28)

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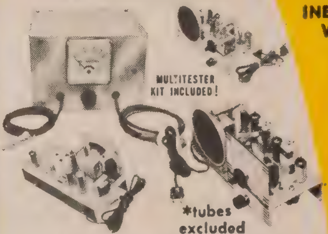

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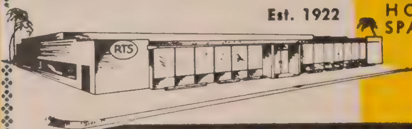

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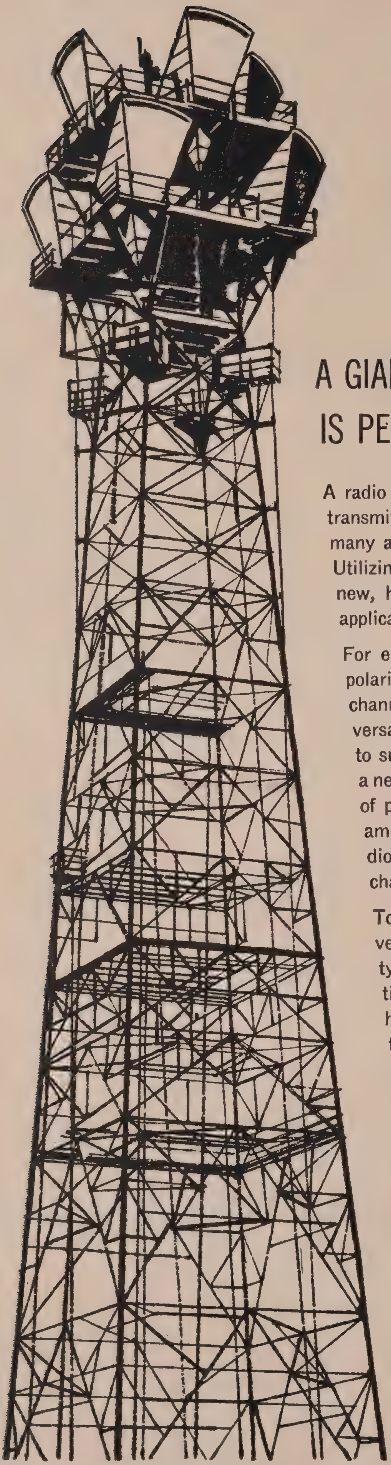

A GIANT RADIO HIGHWAY IS PERFECTED FOR TELEPHONY

A radio relay system operating at 6 billion cycles per second and able to transmit 11,000 voices on a single beam of microwaves—several times as many as any previous system—has been developed at Bell Laboratories. Utilizing the assigned frequency band with unprecedented efficiency, this new, heavy-traffic system was made possible by the development and application of new technology by Bell Laboratories engineers and scientists.

For example, they arranged for the waves in adjacent channels to be polarized 90 degrees apart, thus cutting down interference between channels and permitting the transmission of many more telephone conversations in the same frequency space. They developed ferrite isolators to suppress interfering wave reflections in the waveguide circuits; and a new traveling wave tube that has ten times the power handling capacity of previous amplifiers and provides uniform and almost distortionless amplification of FM signals. They devised and applied a new high-speed diode switching system which instantly switches service to a protection channel when trouble threatens.

To transmit and receive the waves, the engineers applied their invention, the horn-reflector antenna. Elsewhere, this versatile antenna type is brilliantly aiding space communication research in the reception of radio signals from satellites. For radio relay, a single horn-reflector antenna can efficiently handle both polarizations of the 6000 megacycle waves of the new system; at the same time it can handle 4000 and 11,000 megacycle waves used for existing radio relay systems. Thus it enables all three systems to share economically the same radio towers and routes.

Produced by the Bell System's manufacturing unit, Western Electric, the new system is now in operation between Denver and Salt Lake City, and will gradually be extended from coast to coast. This new advance in radio technology is another example of how Bell Telephone Laboratories works to improve your Bell communication services.

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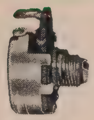
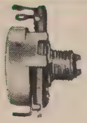
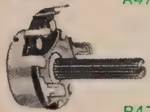
SERIES A47, B47S, C47S **CARBON** CONTROLS



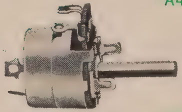
A47



A47F

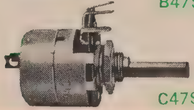


B47



B47S

AD47



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Ad-A-Switch feature available on all types except B47 and C47S. Pick-A-Shaft advantage available on all except B47-B47S.

A47 ½ watt control.
A47F ½ watt control with taps.
B47 ½ watt control, tab mounting, phenolic shaft for "hot" chassis.
B47S ½ watt control, tab mounting, with SPST switch, metal shaft. Not for "hot" chassis.
AD47 ½ watt dual controls.
C47S ½ watt control with push pull switch.

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A43

A43S

Resistance values up to **50K**, 2-watt wire-wound controls meeting servicing requirements of radio and television with all popular values. Available with or without power switch. Your choice of shaft with Pick-A-Shaft feature. Clarostat also offers 3-watt Series 58 and 4-watt Series 10 wire-wound controls for heavier power requirements.

A43 2-watt control.
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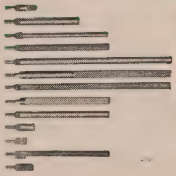

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CLAROSTAT

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Listen!.. with your own magnetic... or with any magnetic you can buy today—at *any* price. Then replace it *directly* in your component system with Sonotone's new "VELOCITONE" STEREO CERAMIC CARTRIDGE ASSEMBLY. Listen again! We challenge you to tell the difference. Experts have tried...in dozens of A-B listening tests. And, in every single one, Sonotone's "VELOCITONE" performed as well as or better than the world's best magnetic.

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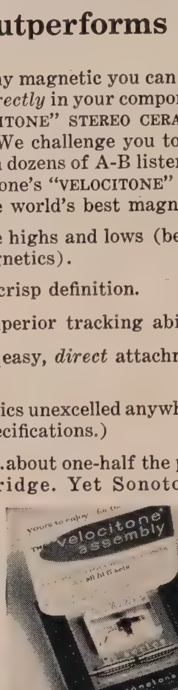
Now listen to the price. Only $23.50...about one-half the price of a good stereo magnetic cartridge. Yet Sonotone's "VELOCITONE" stereo ceramic cartridge system cannot be outperformed by any magnetic—regardless of price.



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(*Continued from page 22*)

"breakthroughs" haven't had time to dim.

The ultimate success in speakers will constitute recognition of physical laws. At the moment, my own "cardinal points" for correct sound reproduction are: optimum size; avoidance of rattles, shadows and cavities. These criteria are necessary; they also suffice to condemn the majority of designs currently advertised. PAUL W. KLIPSCH
Klipsch and Associates Inc.
Hope, Ark.

WHERE'S THE WATT?

Dear Editor:

I have been reading RADIO-ELECTRONICS for some 10 years. You have a very good magazine. In your June, 1960, issue, you described the first American AM–FM all-transistor receiver. In the story you say that audio output from a 5 x 7 speaker is ½ watt undistorted.

Boy, would I like to see that! You must be pushing 12–15 watts into the speaker coil. If the set is that good, it should sell like hot bread.

Seriously, it must be one thing or the other. Assuming the set is that good, "audio output is ½ watt" would be quite in order, as it wouldn't matter where the sound is coming from. On the other hand, I think what you should say is "audio output is ½ watt undistorted into a 5 x 7-inch speaker."
NEVILLE YOUNG
Barbados, W. I.

[You're right, and we'll say it that way right here and from here on. *"Audio output is ½ watt undistorted into a 5 x 7-inch speaker."—Editor*]

ZENERS

Dear Editor:

Re the Zener diode story in your January, 1961, issue on page 32. Zeners do indeed cost less than formerly, but, at several dollars each, may still be above the reach of the limited-budget experimenter. For this group, the Hoffman HB series (44-cent) Zeners are available. Supplier catalogs list six values, from 6.8 volts to 170 volts, 150-mw dissipation minimum.

Zener regulation is superior to a VR tube, and two Zeners in cascade (separated by resistance) yield really rock-stable voltage. Moreover, unlike VR tubes, Zeners will clip raw unfiltered power dc.

However, *do not* check such clipped dc with your vom! I have not seen this warning in Zener literature, so the reason follows.

If the ac input voltage varies, the clipped dc wave has varying width, so that, even though the clipped voltage is constant, the current, and therefore wattage, is varying. Now all voltmeters are wattmeters (power-actuated devices) calibrated in volts, and a vom absorbs much more power than a vtvm or scope. Hence, a vom across a good clipping diode will indicate a variation of current, not of voltage. Use only your vtvm or scope to check clipped voltage. JOSEPH H. SUTTON
Kansas City, Mo.

END

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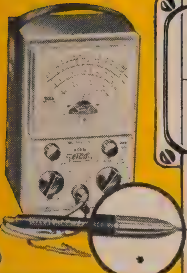

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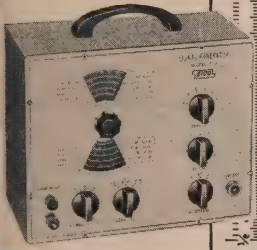

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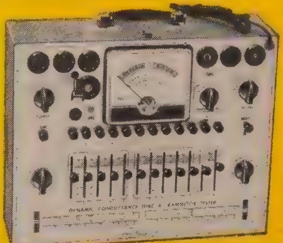

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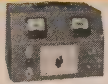

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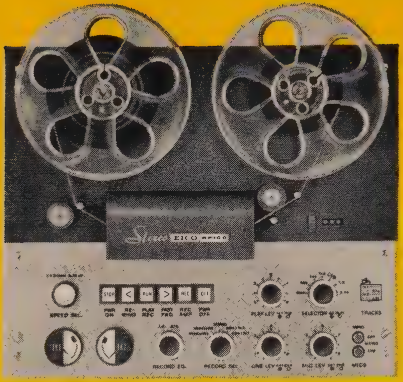

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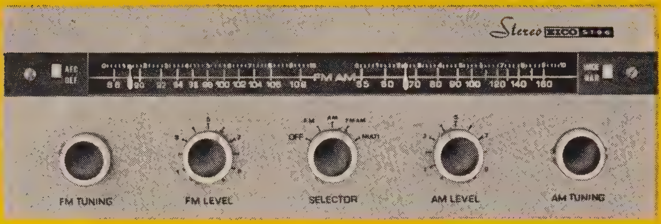

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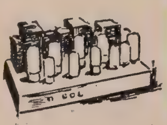

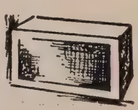

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Radio-Electronics
Hugo Gernsback, Editor

BIO-ELECTRONICS

. . . *Recent Advances in Bio-electricity* . . .

WE have reported on this page from time to time the various advances in bio-electronics and their significance in current and future medicine.*

In our annual publication, *Forecast 1959*, we stated:

"It should be understood that many of man's organs create electricity and we learn a great deal, particularly about disease, when we take tape recordings of these biological currents. There are now many textbooks on the use of electrocardiographs as well as electroencephalographs in diagnosis. But these two instruments are only the beginning. Scores of other new instruments and apparatus will soon open up hitherto undreamt-of avenues of research. Let us consider only that all of the following generate electrical currents, which have not been fully explored nor in some cases even directly investigated:

"All muscles—a huge field. All nerves—an equally important field in which some progress has been made. Sight is electrochemical, mostly investigated only theoretically so far. All glands, so far as is known, produce electrical currents. The human memory functions electrically. Hearing is electrical. Taste is largely electrical, so is smelling. The reproductive act is electrical, too. Circulation of blood and other bodily liquids generate electricity as well."

As newer and better electronic tools become available, the new field of bio-electronics advances by leaps and bounds and steadily increases our knowledge of animal anatomy and its life processes. A recent paper by Dr. Walter R. Volkers, president of Millivac Instruments Division of Cohu Electronics, Schenectady, N. Y., and his medical collaborator, Dr. William Candib, internist, and member of the staff of Ellis Hospital and St. Clare's Hospital, Schenectady, reveals new and important advances of muscle signal emission.

It would seem that the recent perfection of low-noise—almost noise-free—amplifiers, such as "hushed transistor amplifiers" and the new high-impedance low-noise vacuum-tube amplifiers, has opened the door to greatly improved measuring techniques and medical diagnostic interpretations.

Dr. Volkers' paper, "Detection and Analysis of High-Frequency Signals from Muscular Tissues with Ultra-Low-Noise Amplifiers," was read before the IRE national convention in New York, March 1960. It throws a good deal of new light on bio-electronic muscle processes, better known under the all inclusive name of electromyography. Volkers states:

"In tracing the frequency spectra of various muscles, it was discovered that the frequency components of muscle signals reach much further into the high-frequency region beyond the audio range than had been anticipated. *Consequently, a mild curiosity and speculation may be justified as to whether or not the human body is capable of transmitting and receiving electromagnetic high-frequency signals. This aspect is treated with due caution, in view of the fact that more evidence is needed before a definite statement can be made that the human body is both an effective radio transmitter and receiver.*" (The italics are ours.)

As we reported in our article on electromyography in September 1959, the prevailing technique then consisted in inserting insulated needle electrodes directly into the muscles of the patient. This would seem to be an obsolete method now. States Dr. Volkers:

"Remarkable progress has recently been made toward reduction of random noise in electronic amplifiers; we can now record electromyograms in much clearer and finer detail. The higher sensitivity of these amplifiers has also greatly reduced the need for insertion of needle electrodes into muscles. Instead, nearly all myograms can now be obtained by application of surface electrodes.

"Needle insertion, prior to the development of our technique, has generally been preferred by myographers to surface electrodes because it furnishes substantially stronger signals and, therefore, tolerates more amplifier background noise, without obscuring the clinical content of the recording. Needle electrodes, on the other hand, have a tendency to upset the patient (and possibly the physician), emotionally. The muscle itself, after insertion of an electrode needle, becomes definitely disturbed and temporarily loses its ability to relax completely. Therefore, a reasonable time has to be allowed (ranging from 10 minutes to an hour) before recordings are made. If the muscle should fail to regain its normal status of complete relaxation during this allotted time, the recording should either be considered doubtful or it may be necessary to discard it entirely."

Of great interest is the fact that Volkers found that diseased muscles gave different high-frequency signals from normal muscles. This suggests practical applications in the diagnosis of muscle disorders in the future.

Volkers also states that "different patients and control persons showed such strong variations of their frequency response curves (frequency spectra), obtained with the narrow-band filter, that further evidence of high-frequency components began to accumulate (say, above 10 or 20 kc). These high-frequency components are more pronounced in one person than another.

"Our most important consideration, however, concerns the immediate clinical and diagnostic value of our measurement and methods since they already show such drastic differences between healthy persons and patients.

"The main purpose of our measurement, so far, has been a qualitative rather than a quantitative investigation and should be considered as such. In other words, at this time we are satisfied that these high-frequency components exist, at least within frequencies ranging far beyond the old limits of electromyography, 1 kc, 2 kc or, at the very most 10 kc."

Dr. Volkers closes his most interesting paper with a rather daring speculation:

"It is hoped that this paper will stimulate research in this direction and that by a long chance individuals may eventually be discovered who can, either at will or under some other influence, cause their muscles and neuromuscular junctions to generate short high-voltage pulses similar to those which the electric eel is capable of producing. Before such discovery is made, and until then, we will have to be content with our high-frequency millimicrovolts, microvolts and millivolts. With our new, low-noise amplifiers we can measure them now and we may have to stretch our imagination and resort to intensive further research in trying to prove that the high-frequency components of our muscle signals, although they are minute in size, can be sufficiently strong to be used for communication between individuals. Naturally we would also have to discover an efficient biological receiving mechanism in our body to make such high-frequency transmission with weak signals possible.

"The measured magnitude of these signals makes this seem unlikely. Yet, if a neuromuscular mechanism should be discovered in a human body, which is capable of correlating elementary fiber or junction signals in the manner in which a much more primitive creature, such as the electric eel, can do it, radio transmission and reception between individuals would no longer be a wild speculation but a perfectly plausible phenomenon which engineers can easily explain to their medical colleagues." —*H.G.*

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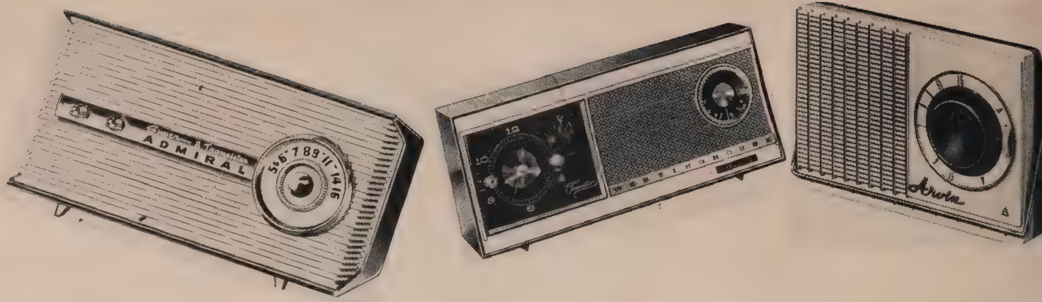
*"Biological Electronics," RADIO-ELECTRONICS, July 1949, P. 19; "Electromyography," RADIO-ELECTRONICS, September 1959, P. 29.


ADMIRAL
5·6·7·8·9·11·14·16
Arvin

OFFBEAT TRANSISTOR

By ROBERT F. SCOTT
TECHNICAL EDITOR

Novel agc and reflex circuits in superhet transistor radios—where they are and how they work

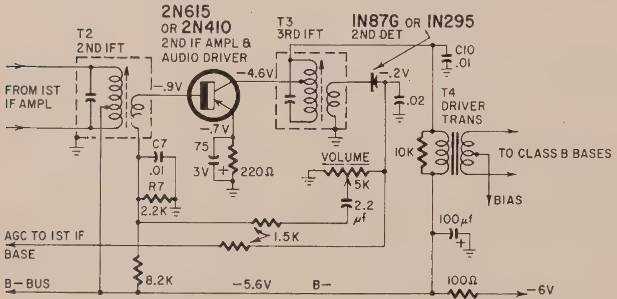

2N615
OR 2N410
2ND IF AMPL &
AUDIO DRIVER
T2
2ND IFT
T3
3RD IFT
IN87G OR IN295
2ND DET
C10
.01
FROM 1ST
IF AMPL
-.9V
-4.6V
-.2V
.02
T4
DRIVER
TRANS
-.7V
C7
.01
75
3V
220Ω
VOLUME
5K
10K
TO CLASS B BASES
R7
2.2K
2.2
μf
BIAS
100μf
AGC TO 1ST IF
BASE
1.5K
8.2K
B-BUS
-5.6V
B-
100Ω
-6V

Fig. 1—Reflex circuit in Westinghouse H-690P5 eliminates need for separate audio driver.

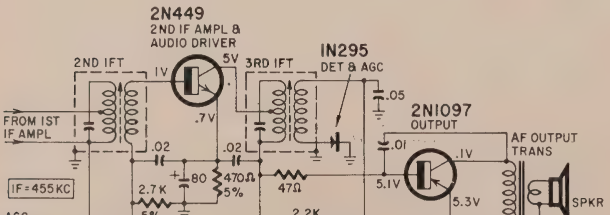

2N449
2ND IF AMPL &
AUDIO DRIVER
2ND IFT
1V
5V
3RD IFT
IN295
DET & AGC
.05
2N1097
OUTPUT
FROM 1ST
IF AMPL
.7V
.02
.02
.01
AF OUTPUT
TRANS
.1V
IF=455KC
80
470Ω
5%
47Ω
5.1V
2.7K
5%
5.3V
SPKR
AGC
2.2K
220Ω
1μf
VOLUME
51Ω
5%
80
100Ω
820Ω
5%
100Ω
5K
12K-5%
TO CONV
6V

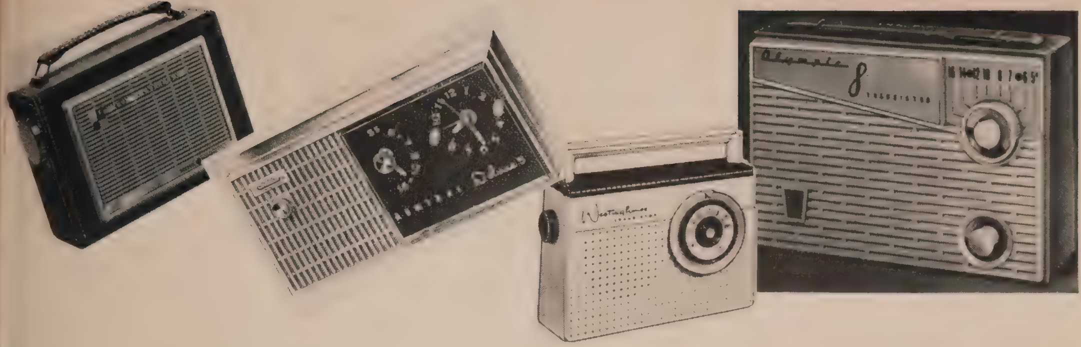
Fig. 2—Another reflex circuit, this time from Arvin 7595.

NEARLY all radio service tech
cians can visualize the circuit
the average broadcast receiv
from its tube lineup and can succe
fully service the set without a sc
matic. Most transistor radio circuits a
also about as cut-and-dried as a
year-old ac–dc five-tuber. But there a
circuit variations that can make tra
sistor sets tough to service without
schematic. A study of some of the le
common ones will enable you to do
better and faster job of servicing so
of those "original" transistor receive
This article covers agc and reflex c
cuits in superhets.

Reflex amplifiers

Reflex amplifiers have been used
vacuum-tube radios and TV receiv
to save space and components and
reduce power drain. In the past we ha
described reflex if–audio, if–video a
rf–if amplifiers in TV and radio se
Now, reflex if–audio circuits ha
started to appear in quality transist
receivers. Fig. 1 is a reflex circ
that eliminates a separate audio driv
without deteriorating if or audio pe
formance. It is from the Westinghou
model H-69OP5. A similar circuit
used in the Admiral 5E5B and 8T
chassis.

The second if amplifier is connect
in a common-emitter arrangement. T
455-kc if signal is applied to the ba
circuit and amplified in the collect
circuit. C10 bypasses the low-potent
end of T3's primary to ground a
prevents the if signal from appeari
across the primary of driver tran



RADIO CIRCUITS

former T4. T3's secondary feeds the amplified signal to the second detector.

The detector output appears across the 5,000-ohm volume control that serves as the detector load. The audio voltage from the volume control is applied across the 2,200-ohm resistor (R7) between the transistor's base and ground. An amplified audio signal appears in the collector circuit and is developed across the primary of driver transformer T4. The signal is then amplified by a push-pull class-B output stage. Base and collector if bypass capacitors C7 and C10 have negligible effect on the range of audio frequencies handled by the receiver.

The dc component of the detector output is filtered and used as avc bias for the first if amplifier (not shown). The avc circuit is engineered to minimize overloading in the reflex amplifier.

Fig. 2 is a somewhat similar reflex circuit used in the Arvin 7595. Here, the detected audio signal appearing across the volume control is fed through a 1-μf capacitor and 100-ohm resistor to the base return circuit of the second if amplifier. The 820-ohm resistor in the collector circuit takes the place of T4's primary in Fig. 1. The amplified audio is coupled directly to the base of the audio output stage.

Agc circuits

Transistor mixers and rf and if amplifiers are very sensitive to agc voltage levels. Too little agc voltage permits one or more stages to overload on strong signals. Too much control voltage biases the transistors into a nonlinear region, and the output is distorted. For this reason, many transistor sets have a dual-acting agc circuit.

Primary agc voltage is developed by the dc component of the detected signal from a diode or class-B transistor detector. This voltage is graded so its range is great enough to handle weak and moderately strong signals. On very strong signals an auxiliary circuit cuts in to reduce circuit gain and prevent overloading.

In most circuits, the auxiliary agc consists of a diode (often called the overload diode) connected across the primary of the first if transformer. The diode is biased so it cannot conduct on signals of normal strength. Very strong signals override the bias and cause the diode to conduct, reducing the gain of the associated if stage by damping and reducing the effective Q of the tank circuit of the if transformer. Fig. 3 shows a typical diode overload circuit and Fig. 4 shows how a CK879 transistor is connected as a diode in the Olympic model 808 and Coronado RA48-9905A.

Fig. 5 is the unusual auxiliary agc circuit in the Admiral 8S1 chassis used in the model 561 and 566. The detected voltage developed across the volume control is filtered by R14, C17 and R1, and fed to the base of the mixer and the first if amplifier. This agc voltage is positive and is proportional to signal strength. As it increases, the collector current (and therefore the gain) of the controlled stages decreases in proportion.

Auxiliary agc is handled by transistor V4, whose collector and emitter are tied across the primary of the first if transformer through R4. V4's base is biased by R8 in the collector return of V2. Under normal signal strength, the voltage drop across R8 is great enough to bias V4 to cutoff so it has no effect on circuit operation.

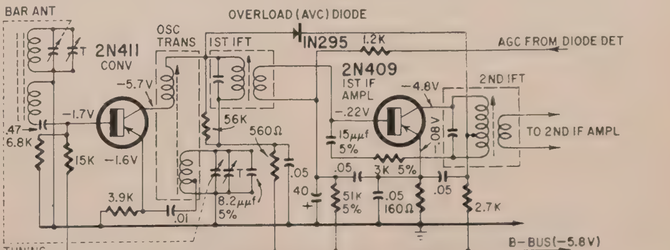


Fig. 3—Typical diode overload circuit.

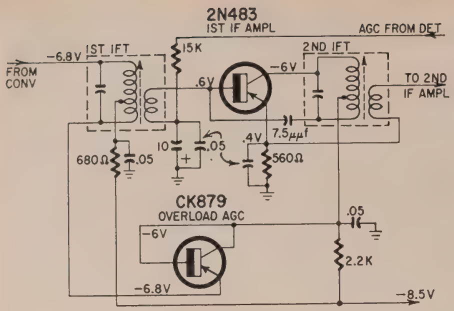
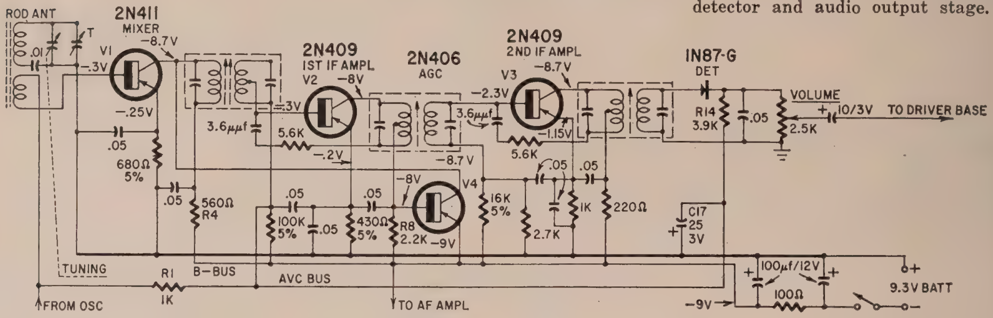

2N483
1ST IF AMPL
AGC FROM DET
FROM CONV
-6.8V
1ST IFT
15K
2ND IFT
.6V
-6V
TO 2ND IF AMPL
10
.05
.4V
7.5μμf
680Ω
.05
560Ω
CK879
OVERLOAD AGC
.05
-6V
2.2K
-6.8V
-8.5V

Fig. 4—Transistor connected as diode in Olympic 808.

Fig. 5 — Auxiliary agc circuit used in Admiral 8S1 chassis.


ROD ANT
2N411
MIXER
T
.01
V1
-8.7V
-.3V
-.25V
.05
680Ω 5%
.05
560Ω R4
2N409
1ST IF AMPL
V2
-8V
-.3V
3.6μμf
5.6K
-.2V
2N406
AGC
-8.7V
-8V
V4
.05
100K 5%
.05
.05
430Ω 5%
R8 2.2K
-9V
2N409
2ND IF AMPL
V3
-8.7V
-2.3V
3.6μμf
-1.15V
5.6K
16K 5%
.05
.05
2.7K
1K
220Ω
1N87-G
DET
R14 3.9K
.05
VOLUME
10/3V
TO DRIVER BASE
2.5K
C17 25 3V
TUNING
R1 1K
B-BUS
AVC BUS
FROM OSC
TO AF AMPL
100μf/12V
100Ω
9.3V BATT
-9V

On stronger signals, the primary agc voltage decreases V2's collector current until the voltage drop across R8 is no longer high enough to hold V4 at cutoff. Current flows in V4's emitter–collector circuit, and V4 appears as a low impedance shunted across T1's primary. This reduces the effective Q of the transformer, further reducing V1's gain and eliminating the possibility of overloading.

Agc from class-B detector

Fig. 6 is the agc and detector circuit in the Westinghouse H-685P5 and similar models. It features a class-B detector and primary agc source and a 1N295 auxiliary agc or overload diode. A part of the emitter bias for the first if amplifier flows from the —4.4-volt line through R12, the secondary of the third if transformer, R11, R13 and R6 to ground. The voltages shown are those with no signal input.

When a signal is tuned in, the detector conducts and emitter current flows to ground through R14, R13 and R6. This increased current through R6 makes V2's emitter more negative (less negative with respect to the base). This reduction in V2's forward bias reduces collector current and stage gain.

As the collector current drops, the voltage drop across R7 decreases. The collector and the cathode of the 1N295 rise toward the —4.4-volt line. This decreases the reverse bias on the diode. On very strong signals, V2's collector rises above —4 volts and biases the diode in the forward direction so it conducts. The diode now appears as a low resistance in series with C10 across the primary of the first if transformer. This lowers the Q of the circuit and reduces the amount of signal fed to the first if amplifier.

A different type of agc was used in some of the early transistor portables such as the G-E 675. The if, audio and agc circuit is shown in Fig. 7. The detector is a class-B type with emitter bias flowing through R12, which is in series with the minus supply line to the converter and if amplifier stages.

When no signal is coming in, the detector is biased nearly to cutoff and the voltage drop across R12 is produced by current drawn by preceding stages. When a signal is received, the detector draws current proportional to signal strength, and the voltage drop across R12 increases. This makes the bias on the if amplifier and converter less negative as signal strength increases, reducing the gain of these stages.

The gain of the first if amplifier is reduced more than that of the second. In the first if amplifier, the added drop in R12 changes the bias on the base and collector with respect to the emitter, which is tied directly to a —4.5-volt tap on the battery. The reduction in gain of the second if amplifier is not as great because its base and collector are returned to the —8-volt line.

While on Fig. 7, we'll take a quick look at the direct coupling between the detector and audio output stage. The detector is biased so it conducts only on positive half-cycles of the modulated if signal. Collector current flows through the volume control and produces a modulated negative voltage that is proportional to signal strength and the setting of the control. This voltage simultaneously biases and feeds the audio signal to the base of the output stage.

Subsequent articles on transistor receiver circuitry will cover the different types of output-transformerless audio circuits and converters and mixers. END

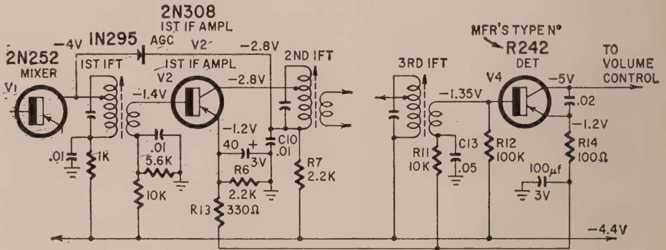

2N308
1ST IF AMPL
-4V
1N295
AGC
V2
-2.8V
2N252
MIXER
V1
1ST IFT
1ST IF AMPL
V2
-2.8V
2ND IFT
-1.4V
-1.2V
C10 .01
40
R6 3V
.01
5.6K
10K
.01
1K
2.2K
R13 330Ω
R7 2.2K
MFR'S TYPE No
R242
DET
3RD IFT
V4
-5V
TO VOLUME CONTROL
-1.35V
.02
-1.2V
R11 10K
C13 .05
R12 100K
R14 100Ω
100μf
3V
-4.4V

Fig. 6—Agc and detector circuit of Westinghouse H-685P5.

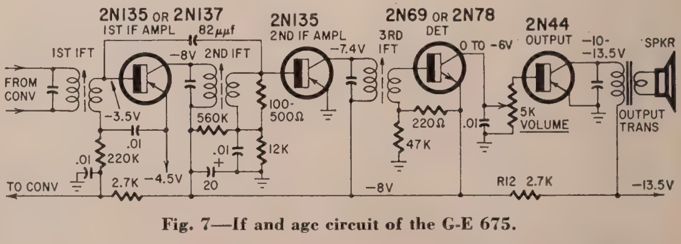
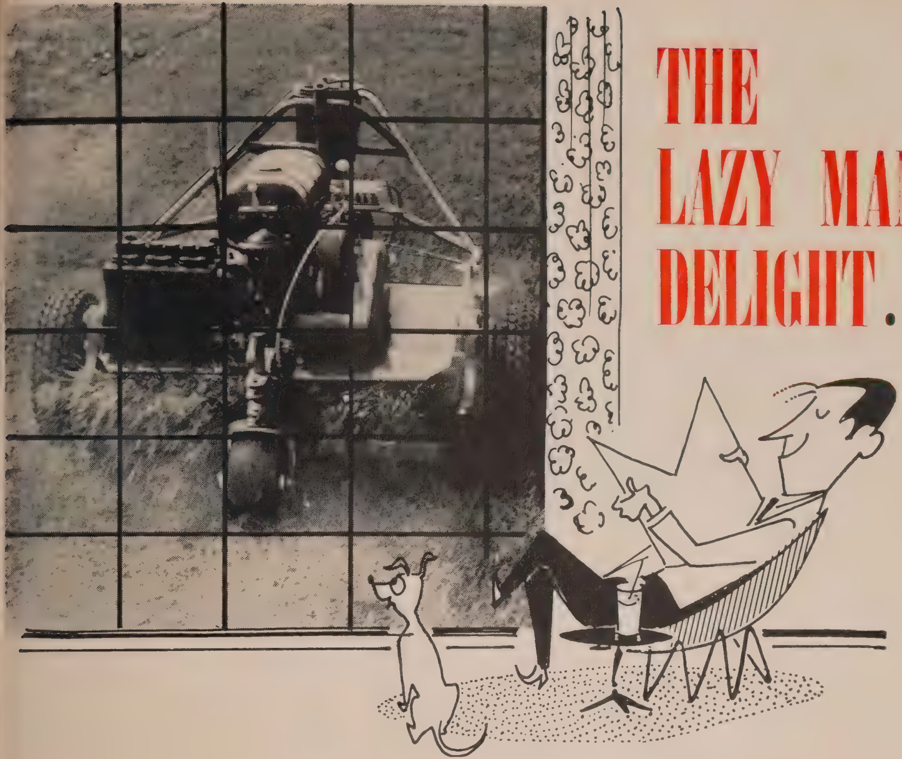

2N135 OR 2N137
1ST IF AMPL
82μμf
2N135
2ND IF AMPL
2N69 OR 2N78
DET
2N44
OUTPUT
1ST IFT
-8V
2ND IFT
-7.4V
3RD IFT
0 TO -6V
-10- -13.5V
SPKR
FROM CONV
-3.5V
560K
100-500Ω
220Ω
.01
5K VOLUME
OUTPUT TRANS
.01
.01
220K
.01
12K
47K
TO CONV
2.7K
-4.5V
20
-8V
R12 2.7K
-13.5V

Fig. 7—If and agc circuit of the G-E 675.

COVER STORY



THE LAZY MAN'S DELIGHT... ...An Automated Lawnmower

By **GORDON CARLSON***

MUCH has been done with remote control, but a remotely controlled device that must maneuver in tight places (such as a grass cutter near the wife's flower beds) and in near panic situations (like a very close miss) requires constant and close observation. This means radio control from the lawn chair is out. Instead, a completely reliable, fully automatic device that doesn't require watching, that does not run over the neighbor's dog or the children's toys is the type of easy living lawnmower that allows plenty of time for relaxation.

Basically, the operation of this automatic lawnmower is this: A length of ordinary plastic-covered hookup wire is buried about 1 inch under the lawn in the pattern the grass is to be cut (Fig. 1). The distance between wires depends on the width of the cutting blade and the amount of overlap desired.

Mounted about 16 inches in front of the steerable wheel of the mower are two pickup coils (Fig. 2), about 6 inches apart and 2 inches above the lawn. When a small alternating current is passed through the buried wire, an electromagnetic field is set up around it.

When the coils are near the wire, the magnetic field induces voltages in them. The amplitude of these voltages increases as the coils move nearer the wire. If the coils are equally distant

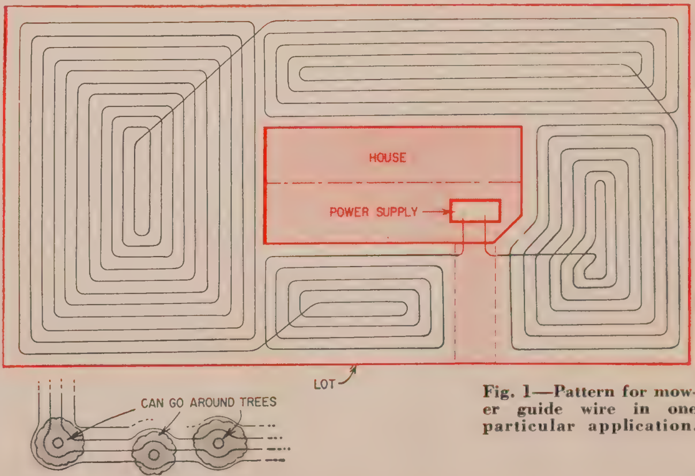


Fig. 1—Pattern for mower guide wire in one particular application.

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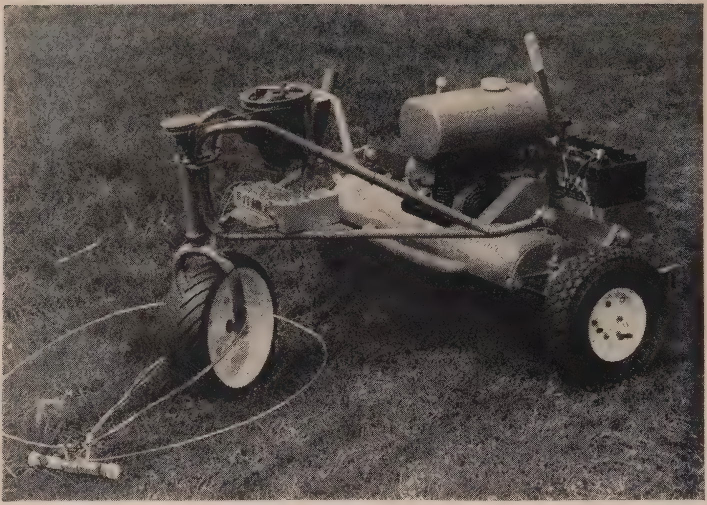
*Development engineer, DeVry Technical Institute, Chicago, Ill.



With all electronics mounted, the mower is ready to go. Hoop-like wire around front wheel is safety device.

from the wire, their induced voltages are equal. If they are moved so one is closer to the wire than the other, unequal voltages are induced.

The output of each pickup coil is fed into a four-stage ac amplifier (Fig. 3). The amplifier output signals are rectified and combined in the comparator circuit to produce a dc difference signal which is applied to the two dc relay amplifiers. When equal-amplitude signals are fed to the comparator, its output is zero. When signals of unequal amplitude are applied, the comparator outputs are proportional to the difference in signal amplitude, but of opposite polarities. The relay amplifier whose base is driven negatively conducts more heavily and picks up its relay, while the other amplifier is driven almost to cutoff.

Since the relays the amplifiers operate are small, power relays capable of handling the steering motor currents are connected to them. Actually the relays form a sort of amplifier, permitting an 8-ma signal to control a 2-amp load.

The coils are in front of and mechanically connected to the steerable wheel so they move when it turns (Fig. 2). Thus if the wheel direction is not exactly correct, the coils drift off the ideal location over the buried wire and produce an error signal. This signal causes the amplifier, the relays and the motor to reposition the coils correctly over the buried wire.

An arrangement as simple as this is far from an ideal servo system since it would be constantly hunting. To reduce hunting, a two-speed steering system is used. When a small error is detected, the motor turns at about two-thirds speed to reposition the coils. Larger errors (such as in a tight curve) cause the motor to run at full speed to make the largest part of the correction. When the coils approach their mid-position, the motor slows and comes to a stop with little overshoot.

Thus, with both steering control and steering speed control, the lawnmower has all that is needed except safety devices.

An automatic stop relay stops the unit if the coils leave the magnetic field entirely. This relay also protects the mower in case of component failure. Instead of making you run like crazy to save the flower bed or the grass cutter from destroying itself, it just stops and waits to be put back on track. For the protection and preservation of movable obstacles like dogs and toys, a set of feelers extends out in front

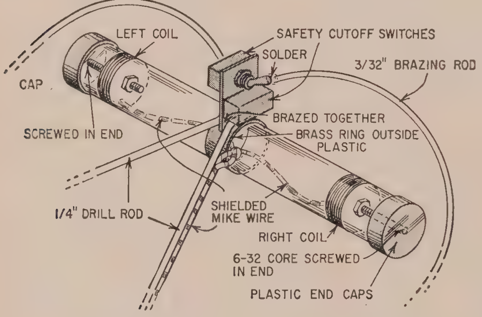

LEFT COIL
SAFETY CUTOFF SWITCHES
SOLDER
3/32" BRAZING ROD
CAP
BRAZED TOGETHER
SCREWED IN END
BRASS RING OUTSIDE PLASTIC
1/4" DRILL ROD
SHIELDED MIKE WIRE
RIGHT COIL
6-32 CORE SCREWED IN END
PLASTIC END CAPS

Fig. 2—Details of steering coils and safety cutoff switches.

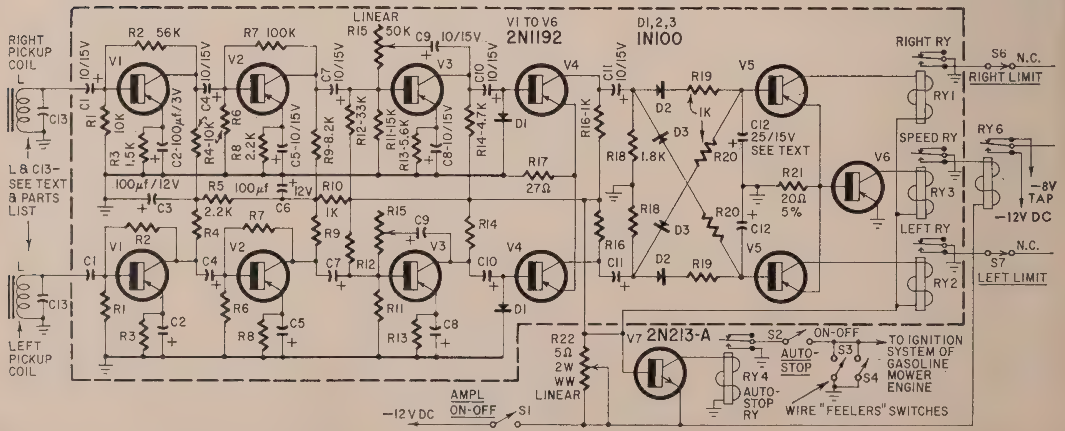
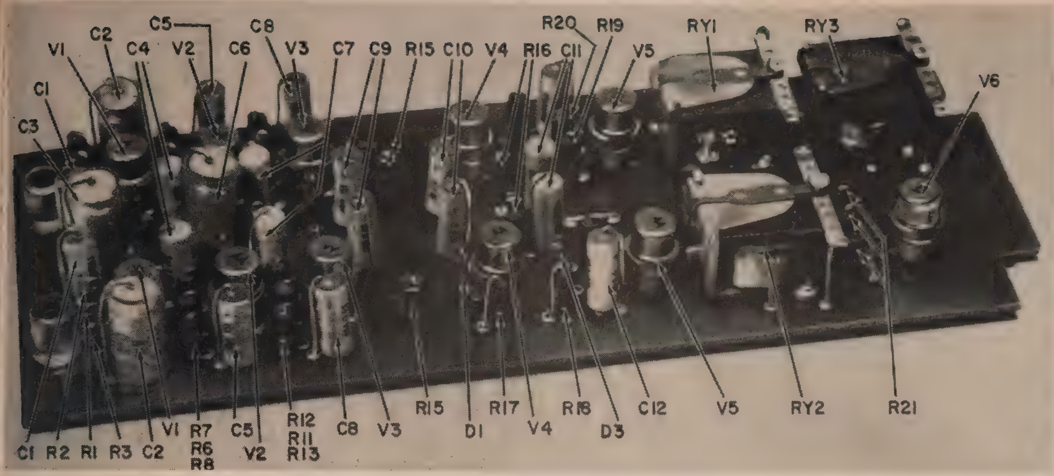

RIGHT PICKUP COIL
L
C13
L & C13- SEE TEXT & PARTS LIST
LEFT PICKUP COIL
C1 10/15V
R1 10K
R2 56K
R3 1.5K
C2-100μf/3V
V1
C4 10/15V
R4-10K
R5 2.2K
C3 100μf/12V
R6
R7 100K
R8 2.2K
C5-10/15V
C6 100μf 12V
V2
C7 10/15V
R9-8.2K
R10 1K
LINEAR R15 50K
C9 10/15V
V3
R12-33K
R11-15K
R13-5.6K
C8-10/15V
C10 10/15V
R14-4.7K
D1
V1 TO V6 2N1192
V4
R16-1K
R17 27Ω
C11 10/15V
D1,2,3 1N100
D2
D3
R18 1.8K
R19
1K
R20
C12 25/15V SEE TEXT
V5
R21 20Ω 5%
V6
RIGHT RY
RY1
S6 N.C.
RIGHT LIMIT
RY6
SPEED RY
RY3
-8V TAP
-12V DC
LEFT RY
RY2
S7 N.C.
LEFT LIMIT
R22 5Ω 2W WW LINEAR
V7 2N213-A
S2 ON-OFF
AUTO-STOP
S3
S4
RY4 AUTO-STOP RY
TO IGNITION SYSTEM OF GASOLINE MOWER ENGINE
WIRE "FEELERS" SWITCHES
AMPL ON-OFF
S1
-12V DC

Fig. 3—Circuit of the 2-channel control amplifier.



Top view of the printed-circuit board. Note upright mounting of components.

of the mower and causes it to stop if physical contact is made with them.

Transistor amplifier

The transistor amplifier uses the grounded-emitter configuration. A combination of bias methods provides a high degree of temperature stability. Both negative voltage and current feedback are used in both V1 and V2 stages (Fig. 3). R2 and R7 provide voltage feedback and, with R1 and R6, stabilize the dc bias current. Even though bypassed, R3 and R8 provide a small amount of current feedback.

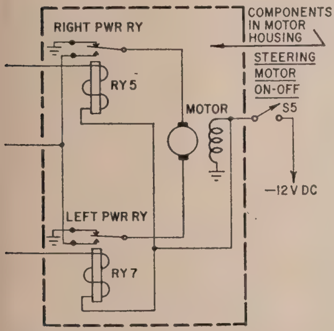
V3 differs from the two preceding stages—the negative voltage feedback is variable. This provides a means of controlling the gain of each channel. The 2N1192 transistors provide more than enough gain so the large amount of negative feedback allows transistor replacement with little or no selection. Increasing the feedback loop to extend beyond one stage is impractical because problems of low-frequency stability arise.

The comparator circuit introduces some loss and, since it should produce as large a difference voltage as possible, V4 is operated at a fairly high output level. To avoid excessive dissipation in V4, the bias current is developed by rectifying the incoming signal with diode D1. This form of variable bias eliminates the need of the stabilizing feedback used in the preceding three stages. Since both amplifier channels are identical, and with the signals from the pickup coils in phase, signals throughout the ac amplifiers are in phase channel for channel.

V4's common-emitter resistor, R17, aids in producing greater voltage differences between channels. When the pickup coils produce an error signal, the increase of signal in one channel and the corresponding decrease in the other vary logarithmically, causing the voltage across R17 to increase. Thus there is more bias and the channel having the smaller input signal further decreases its output. In the comparator —D2, D3, R18, R19, R20 and C12— the signals are rectified along with the inversion of the polarity of the smaller voltage.

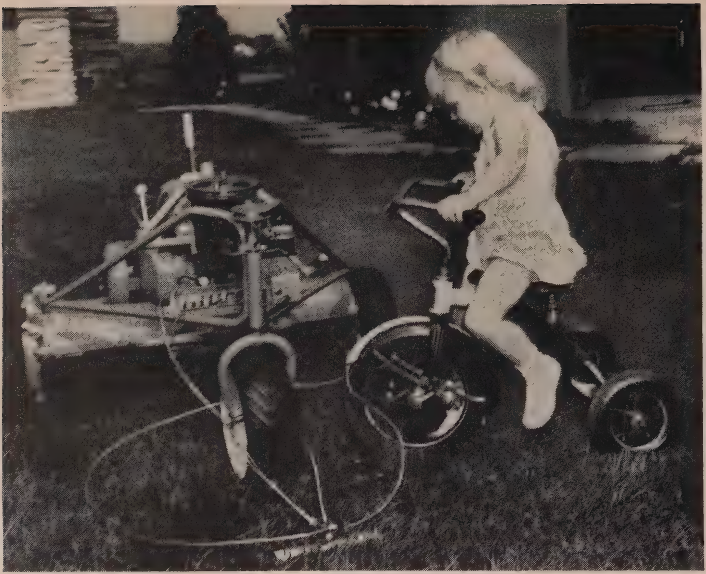
The channel that feeds the larger signal into the comparator drives its V5 stage base positive; the smaller signal, negative. In the V5 stage, resistor R21 is common to both emitters. When a larger than normal error voltage is produced, the conducting V5 stage carries more than average collector current. This produces enough bias current to cause V6 to conduct. The resulting increase in V6's collector current energizes the steering-speed relay.

The normal operating current of the entire amplifier is about 15 to 40 ma, depending on the position of the coils with respect to the buried wire. With no signal, the current drops to about 8 ma. Therefore, in stop amplifier V7, R22 is adjusted so that, normally, the voltage across this resistor keeps V7 conducting and its relay energized. If the voltage across R22 decreases, RY4 is de-energized and shorts out the mower's ignition, stopping its forward



NOTE
DUPLICATED CODES IN LEFT & RIGHT PICKUP COIL CKTS HAVE EQUIVALENT VALUES

R1, R4, R6—10,000 ohms
R2—56,000 ohms
R3—1,500 ohms
*R5—2,200 ohms
R7—100,000 ohms
R8—2,200 ohms
R9—8,200 ohms
*R10—1,000 ohms
R11—15,000 ohms
R12—33,000 ohms
R13—5,600 ohms
R14—4,700 ohms
R15—pot, 50,000 ohms, miniature, linear taper (Centralab B16-119 or equivalent)
R16, R19, R20—1,000 ohms
*R17—27 ohms
R18—1,800 ohms
*R21—20 ohms, 5%
*R22—pot, 5 ohms, 2 watts, wirewound linear taper
All resistors ½-watt 10% unless noted
C1, C4, C5, C7, C8, C9, C10—10 µf, 15 volts, miniature electrolytic
C2—100 µf, 3 volts, miniature electrolytic
*C3—100 µf, 12 volts, miniature electrolytic
*C6—100 µf, 12 volts, miniature electrolytic
C11—10 µf, 15 volts, miniature electrolytic (for 60 cycles)
C12—25 µf, 15 volts, miniature electrolytic (for 600 cycles)
C13—see text
D1, D2, D3—1N100
L—see text
Pickup Coils—from Advance Tiny-Mite M/2C/50000D relays. Remove core and replace with 1-inch long 6-32 threaded rod. Place nut on each end. Excess rod screws into plastic end cap.
MOTOR—surplus, White - Rogers 12 volts, dc, 3 rpm, 150-inch/lb. torque, trim tab motor (Possible sources: Electro Sales, 50-58 Eastern Ave. Boston 9, Mass.; Fair Radio Sales Co., 132 S. Main St., Lima, Ohio; Servo Tech, 1086 Goffle Rd., Hawthorne, N.J.; Lectronic Research Lab, 715 Arch St., Philadelphia 6, Pa.)
*RY 1, RY 2, RY 3, RY 4—spdt, 6 volts dc (Potter & Brumfield RS50 or equivalent)
*RY5, RY7—in motor specified
*RY6—dpdt, 12 volts dc (Potter & Brumfield KA11D or equivalent)
*S1, S2, S5—spst, toggle
*S3, S4—spst, toggle, snap-action type
*S6, S7—spst, roller, snap-action type (Acro BRD2-2M-1S or equivalent)
V1, V2, V3, V4, V5, V6—2N1192
*V7—2N213-A
Transistor sockets (11)
Chassis and case, to suit
Miscellaneous hardware
*1 each of these parts. All others 2 of each.



Safety devices stop mower if it runs into an obstruction.

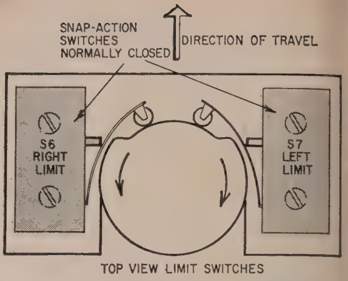


Fig. 5—Closeup of limit switches, section of steering system.

motion. This automatic stop operates any time the mower leaves its buried wire by more than 3 inches, and can be adjusted (with R22) to stop the mower anywhere between 2 and 8 inches.

Construction

To build the amplifier, an etched wiring board was used—an amplifier subjected to the vibration found on a grass cutter has to be very rugged to be reliable. Of course, a perforated insulating board might be simpler for many people. Even a regular chassis with terminal strips would work.

The layout of the parts is not at all critical. Our first breadboard model proved this. Because the input impedances of transistors are low, the only extra care needed is to separate the V1 stages from the V4 stages by 2 inches or more. No special parts were used in the amplifier. The pickup coils are miniature 5,000-ohm relay coils removed from their mountings.

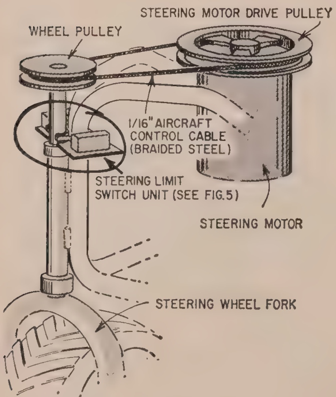

STEERING MOTOR DRIVE PULLEY
WHEEL PULLEY
1/16" AIRCRAFT CONTROL CABLE (BRAIDED STEEL)
STEERING LIMIT SWITCH UNIT (SEE FIG.5)
STEERING MOTOR
STEERING WHEEL FORK

Fig. 4—Details of the steering motor and pulley arrangement.

Capacitors C12 were selected to resonate the pickup coils at the frequency of the ac in the buried wire. Since this unit was to be used for demonstrations here at DeVry Tech and elsewhere, the buried grid of wire was energized with a current of different frequency from that in the ac power line. We didn't want interference from strong magnetic fields that we couldn't control. Our coils resonate at 930 cycles with a .02-μf capacitor. In our demonstration setup, a 10-watt audio amplifier driven by an audio oscillator is used to supply 4,000 feet of No. 20 wire with about 0.4 amp of current.

A unit intended only for cutting grass could use a stepdown transformer to energize the wire at 60 cycles. The same current would be used in the wire. For 60-cycle operation, besides a larger value capacitor for C12, coupling capacitors C1, C4, C7, C9, C10, and C11 should be 20 μf. The amplifier has never failed in any way even though the relays open and close many thousands of times for each cutting of the lawn.

Mechanical details

The lawnmower has an electric starting system which is powered by a self-contained 12-volt battery. With this power source, we used a surplus White-Rogers 12-volt dc, 3 rpm, 150-inch/lb.-torque trim tab motor to handle steering. Two pulleys with a woven steel cable drive the steerable wheel (Fig. 4 for details). A steering speed of 45° of arc per second (7.5 rpm) gives the least hunting while traveling at forward speeds of 5 feet per second or 3+ miles per hour. For higher forward speeds, a steering system that is completely proportional to the input signals would probably have to be used. Limit switches (Fig. 5) keep the steerable wheel from turning too far. The present mower (a Jacobsen Lawn King) has shown that it traces the wire without deviating more than ¼ inch from previous runs. Our mower has differential gears between its two drive wheels. Whether a unit without this feature would work as well has not been determined.

An automatic steering arrangement for other types of power mowers would, of course, be somewhat different. Therefore, details of the steering control will have to be worked out by the builder for the particular mower he is using. In any event, once the job is done, you can sit back to the easiest lawnmowing you ever did. END

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fuel cells

tomorrow's electric generators?

An electric battery with a gas tank

By LEONARD G. AUSTIN

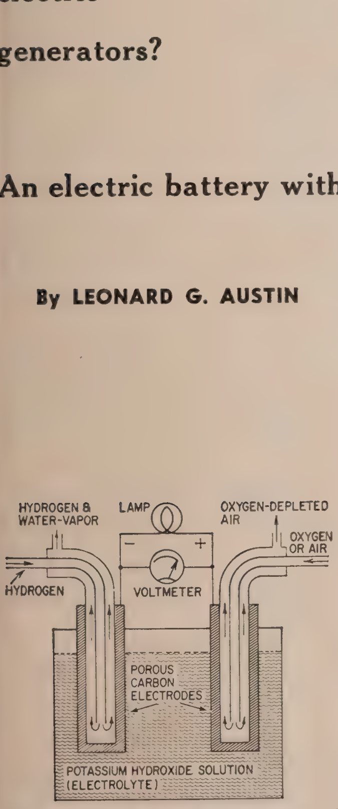


Fig. 1—Typical hydrogen–oxygen fuel cell.

A FUEL cell operates on the same electrochemical principle as the ordinary flashlight battery. However, a fuel is fed into the cell continually so it never runs down as long as fuel and air are available. Unlike lead–acid or nickel–iron–alkaline batteries, fuel cells do not have to be recharged electrically — "recharging" simply consists of refilling the fuel tank. Three major fields are open to fuel cells. They could be used as nonexpendable cells providing cheaper and more reliable electricity than conventional batteries. Used to power electric motors they could take the place of gasoline and diesel engines for road and rail transport. Finally, large fuel-cell installations might generate electric power with greater fuel efficiency and lower cost than central power plants using boiler–steam turbine–generator systems.

Fuel cells can generate small or large amounts of electricity at efficiencies up to 80%. In the past 5 years there has been an explosion of research on the cells. All major companies in the automobile, aircraft, heavy chemical, battery, electrical and oil industries are in keen competition.

The most highly developed fuel cells at present use hydrogen as fuel, oxygen as oxidizer and concentrated potassium hydroxide as the electrolyte. This type of cell will be used to explain the principle of operation of fuel cells. Fig. 1 shows a simple cell of this type. The electrical energy we take from the cell as current and voltage is supplied by the chemical energy of the combination of hydrogen and oxygen to form water. Normally, hydrogen and oxygen will not react until they are heated to over 500°C. The trick in combining hydrogen and oxygen at low temperature to give electrical energy is to make the reaction proceed in a series of catalyzed steps, in one of which an electron is transferred across a circuit. (The catalysis involves a surface which holds reactants and allows them to react at much lower temperatures.)

Fig. 2 shows the series of steps in a fuel cell. It has two porous electrodes separated by a potassium hydroxide electrolyte. On the negative side of the cell, hydrogen gas diffuses through the

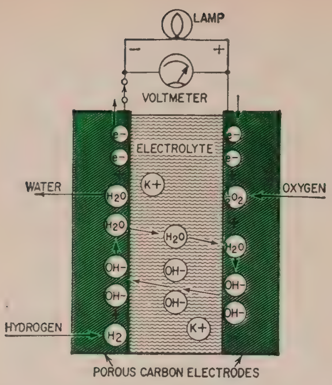


Fig. 2—What happens in a fuel cell when the circuit is closed.

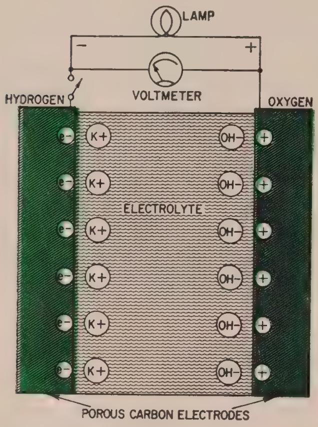


Fig. 3—Open circuit stops reaction.

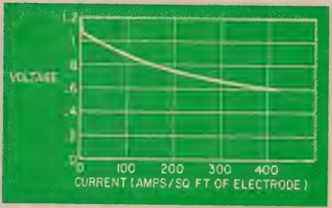


Fig. 4—Current–voltage curve of a hydrogen – oxygen fuel cell.

electrode, and hydrogen molecules (H_2), assisted by a catalyst embedded in the electrode surface, are adsorbed on the surface in the form of hydrogen atoms (H). The atoms react with hydroxyl ions (OH^-) in the electrolyte to form water, giving up electrons to the electrode in the process. The water goes into the electrolyte. This reaction is also aided by the catalyst.

The flow of these electrons through the external circuit to the positive electrode is the electric output of the cell and supports the oxygen half of the reaction. On the positive side of the cell oxygen (O_2) diffuses through the electrode and is adsorbed on the electrode surface. In an indirect reaction, the adsorbed oxygen, plus the incoming electrons and water in the electrolyte, form hydroxyl ions. Here again a catalyst helps the reaction along. The hydroxyl ions complete the circle by migrating through the electrolyte to the hydrogen electrode.

If the external circuit is open, the hydrogen electrode accumulates a surface layer of negative charges that attracts a layer of positively charged sodium or potassium ions in the electrolyte. An equivalent process at the oxygen electrode similarly balances its accumulated positive charge (Fig. 3). These electrical "double layers" prevent further reaction between the gases and the electrolyte. These layers also provide the potential that forces the electrons through the external circuit when an external connection is made.

Theoretically, a fuel cell can convert the available chemical energy of the fuel to electrical energy at almost 100% efficiency. In practice, energy has to be used to overcome the activation energy barriers of the reactions in the cell, overcome the ohmic resistance of the electrolyte and supply the transport energy of feeding the gases through the porous electrode. High current drain makes these losses greater and the cell voltage decreases from the open circuit value (Fig. 4). Efficiencies of 60% to 80% at working currents can be obtained. If we compare this efficiency level with 25–30% for the normal gasoline engine and 35–40% for central electricity power generation, we see why fuel cells are exciting so much interest.

Union Carbide has developed a hydrogen–oxygen cell which operates at about 60°C. The electrodes consist of porous carbon impregnated with catalysts: fine particles of platinum or palladium in the hydrogen electrode and cobalt oxide, platinum or silver in the oxygen electrode. To prevent flooding the pores by the electrolyte—which would cut down the active surface—the electrodes are waterproofed with paraffin wax. The wax prevents the water from creeping into the pores. To bring the electrodes closer together and thus speed ion transport, they are usually arranged as concentric tubes or adjacent plates. These cells are being used by the Army as portable, quiet power generators.

General Electric has developed a low-temperature hydrogen–oxygen cell which uses an ion-exchange membrane instead of a liquid electrolyte. The membrane transports a hydrogen ion (H^+) to the oxygen electrode where it reacts to form water. The electrodes are thin sheets of porous platinum-palladium. This cell is suitable only for small current outputs because of the low ionic conductivity of the membrane; however, it is thin and about 60 cells stacked in series are but 1 foot long.

If the electrochemical reactions are speeded up by running the cells at higher temperatures, hydrogen–oxygen cells are capable of much greater electrical outputs per unit volume. To prevent electrolyte boiling at high temperatures, the whole cell must be pressurized. A cell of this type, developed by Francis T. Bacon of Cambridge University (England), operates at about 250°C with gas pressures that run as high as 800 pounds per square inch (Fig. 5). The porous nickel electrodes are about 1/16 inch thick, usually in the form of disks or plates. The reaction area is a thin, porous surface layer on the electrode. The electrolyte is a solution of potassium hydroxide and could enter these pores but for the pressure differences within the electrode which keep the electrolyte from flooding the larger pores in the body of the electrode. This fuel cell produces six times as much power per cubic foot as the low-temperature hydrogen–oxygen cells.

High-temperature cells

Although hydrogen–oxygen cells have been developed, they have two big disadvantages. Hydrogen is costly and bulky. Hydrogen stored at 150 atmospheres pressure contains less than one-hundredth the energy of the same volume of gasoline at normal conditions. Fuel cells must "burn" cheap fuels (natural gas, vaporized gasoline) to produce economical power on a large scale. Extracting energy from such fuels at present needs operating temperatures above 500°C. Since water-base electrolytes boil away at these temperatures, the electrolyte usually consists of some molten salt, sodium or potassium carbonate, mixed with lithium carbonate to lower the melting

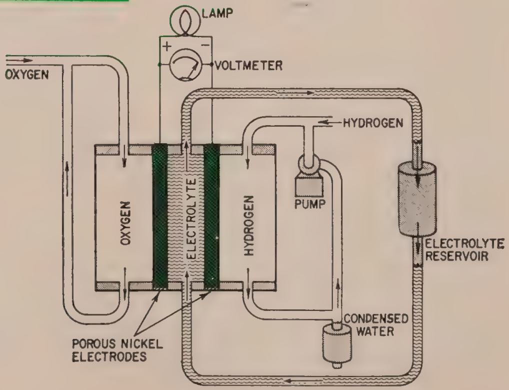


Fig. 5—Francis T. Bacon developed this hydrogen–oxygen cell.

point for example. In the most efficient high-temperature cells, the electrolyte is held in a matrix of porous refractory material. The electrodes, made of a variety of metals or metallic oxides, are tightly pressed against the "solid" electrolyte.

In these cells the fuel is probably "cracked" to hydrogen and carbon monoxide by reaction with steam and carbon dioxide, which the fuel cell produces as byproducts. This cracking may be done outside or inside the cell.

In the current-generating reaction, the hydrogen and carbon monoxide diffuse into the cell at the negative electrode, react with carbonate ions in the electrolyte and form carbon dioxide and water while giving up electrons to the electrode. At the positive electrode, oxygen or air takes up the electrons flowing in from the external circuit, reacts with the carbon dioxide and produces the carbonate ions. Migration of carbonate ions through the electrolyte from the positive to the negative electrode completes the circuit (Fig. 6).

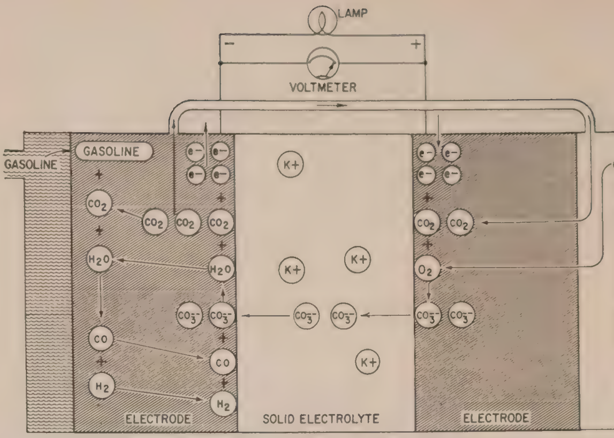


Fig. 6—High-temperature fuel cell uses "solid" electrolyte of potassium carbonate and operates at temperatures above 500°C.

High-temperature fuel cells, intensively investigated only since World War II, still perform poorly. The best of them produce no more than half the yield of the low-temperature hydrogen–oxygen cell and a twelfth the yield of the Bacon cell. However, the progress already made in hydrogen–oxygen cells suggests that further research can greatly improve the performance of high-temperature cells.

Another cell which might be able to use cheap fuels is the "redox" cell (named for reduction and oxidation). In this cell the fuel and oxygen are made to react with other substances in "regenerators" outside the cell to produce chemical intermediates, which in turn generate current in the cell. The overall reaction is the same as that of combustion, however, because the intermediates are regenerated. A typical cell of this type was developed in England under the leadership of Sir Eric Rideal. It uses tin salts and bromine as intermediates (Fig. 7). The fuel reduces (adds electrons to) tin ions, which then give up the added electrons to the negative electrode and return to react with more fuel. The oxygen similarly oxidizes (takes electrons from) bromide ions, converting them to bromine, which then takes up electrons from the positive electrode and returns as bromide ions for regeneration. A similar cell, using titanium salts instead of tin, is under development by the General Electric Co. The stumbling block with this type of cell is that most fuels cannot react quickly enough in the regenerator to keep up the current flow. Investigations of catalysts to speed up the reaction are being made by G-E and by the Pennsylvania State University.

Special-purpose cells

Several other types of cells and many fuels are being investigated. Hydrazine (N_2H_2) and ammonia (NH_3) are being used as fuels in hydrogen–oxygen type cells. They act as convenient hydrogen carriers; a catalyst in the electrode splits them into hydrogen and nitrogen. Methyl alcohol (wood spirit) has been used in similar cells. Although alcohol is not cheap enough to use for large-scale electricity production, it is certainly cheap and convenient enough to replace expensive nonrechargeable dry cells. Allis-Chalmers Co. has developed a cell which runs at 60°C on a fuel mixture of propane and hydrogen. It uses potassium hydroxide electrolyte and activated nickel electrodes. A 20-horsepower tractor has been built using 1,000 of these cells for the power unit. The Electric Storage Battery Co. is developing a cell originated by E. Yeager at Western Reserve University. The fuel is sodium, dissolved in mercury, which reacts with oxygen and water to form sodium hydroxide. It will not produce cheap electricity because of the high cost of sodium, but it may have important defense applications such as powering a quiet submarine.

It does not require a vivid imagination to picture the possible applications of fuel cells. Applications range from electric cigarette lighters fueled with methyl alcohol, to heavy power production for electrical furnaces used by such industrial giants as the aluminum, glass and steel industries. A fuel cell "burning" gasoline or light hydrocarbons could be the power unit of an automobile if it had a satisfactory power to volume ratio, long life and rapid startup. An electric automobile requires no transmission: it could have electrical braking, four-wheel drive and differential wheel speeds for safe cornering. Troubleshooting on such an automobile would be done mainly with a test meter.

There is no doubt that the use of fuel cells will need specially designed electrical and electronic control and testing gear plus engineers capable of using them. However, I should like to emphasize that I have not discussed the many disadvantages and problems remaining to be overcome in the development of fuel cells. It is possible that many of the potentialities of fuel cells will never be reached, but fuel cells in some form for some applications are on the way. END

Further Reading

G. J. Young, *Fuel Cells*, Reinhold Publishing Corp., 1960.

B. R. Stein, *Status Report on Fuel Cells.* ARO Report No. I. Office of the Chief of Research and Development, Department of Army, Washington 25, D. C. ($1.25)

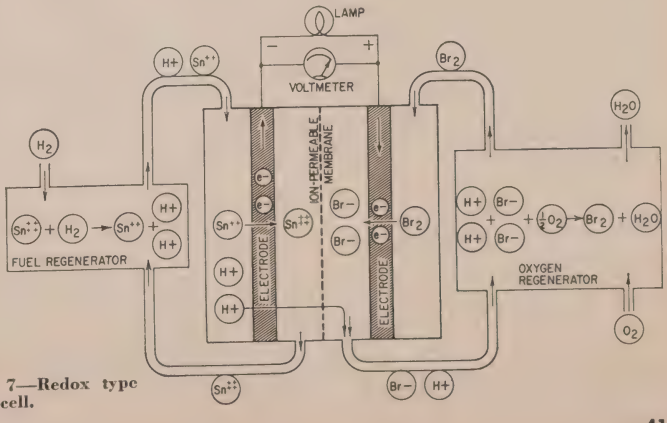


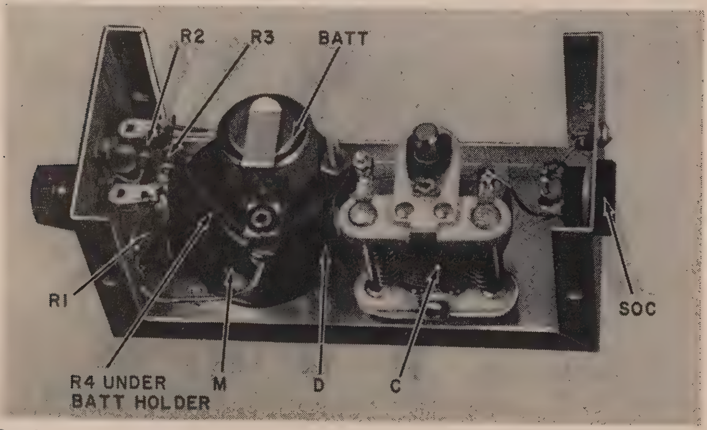
Fig. 7—Redox type fuel cell.

BUILD THIS TUNNEL-DIODE DIP METER

Simpler, more compact grid-dip oscillator made possible by this new semiconductor device

By RUFUS P. TURNER

The completed unit with four of its coils.



Inside view detailing parts layout.

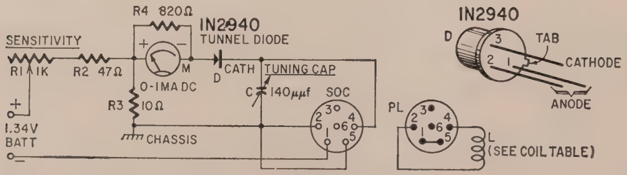


Fig. 1—Circuit of tunnel-diode grid-dip meter.

REPLACING the tube with a transistor simplifies the grid-dip oscillator and cuts down on the cost of batteries. Now, the tunnel diode permits further simplification and size reduction of this versatile instrument. The circuit (Fig. 1) consists only of a dc bias source, milliammeter, tunnel diode and tuned circuit connected in series. The arrangement is no more complicated than a common diode detector or field-strength meter circuit. When properly biased, the diode acts as a negative-resistance oscillator.

Since the tunnel diode is such a simple and ready, single-battery oscillator, amateurs and experimenters may put it to use immediately and to advantage in small, compact test instruments. The dip meter is a natural first choice. The one described in this article is 5 inches long, 2¼ inches wide, 2¼ inches high and weighs only 8 ounces.

With the specified coils, the instrument covers the frequency range of 1.5 to 260 mc in five overlapping bands: 1.5–5.5, 4.7–18, 12–45, 43–160 and 150–260 mc. The range may be extended below 1.5 and above 260 mc with suitable additional coils. The tunnel diode oscillates at frequencies much higher than the upper limit of transistors.

Dip-meter circuit

The complete circuit is shown in Fig. 1. The diode I used originally is a Sperry type T101. Unfortunately, this unit is not readily available, so I tried a G-E 1N2940; it works just as well. The G-E unit comes in a small metal case with three leads and looks much like a transistor. However, leads 1 and 2 are the anode connections—twist them together. Lead 3 is connected to the case and is the cathode terminal. Do not let the metal case of the tunnel diode touch any part of the wiring of the dip meter. A piece of spaghetti over the unit is a good insulator.

The diode must be biased (with anode positive) from a low-resistance dc source. For this purpose, the bias voltage is taken from across R3, the 10-ohm lower leg of the voltage divider R1–R2–R3. Potentiometer R1 allows variation of the bias voltage between approximately 12.5 and 234 mv. This is ample for setting the operating point anywhere within the negative-resistance region of the diode characteristic, necessary for oscillation. We chose a mercury cell as the power source because of the nearly constant voltage delivered

R1—pot, 1,000 ohms, miniature (Centralab WW-102 or equivalent)
R2—47 ohms, ½ watt, 10%
R3—10 ohms, ½ watt, 10%
R4—820 ohms, ½ watt, 10%
C—140 μμf, midget variable (Hammarlund MC140S or equivalent)
BATT—1.34 volts, mercury cell (Mallory RM3R or equivalent)
D— G-E 1N2940 tunnel diode
L—Plug-in coil, see coil table
M—1-inch 0- to 1-ma dc milliammeter (Lafayette TM-400 or equivalent)
PL—6-pin miniature coil forms (Amphenol 24-6H or equivalent) (5)
SOC—6-pin miniature socket with retaining ring (Amphenol 78-S6S)
AIR Dux coil stock No. 416T (1)
AIR Dux coil stock No. 432T (1)
Case, 5x2¼x2¼ inches
Battery holder (Ideal No. 103 or equivalent)
Miscellaneous hardware

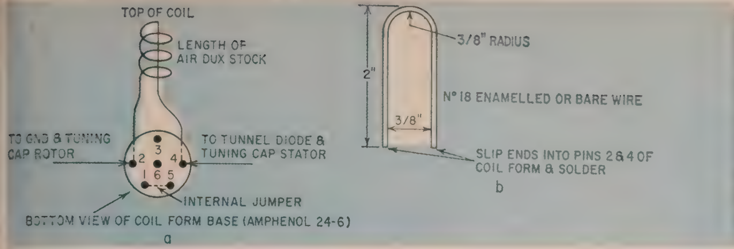

TOP OF COIL
LENGTH OF AIR DUX STOCK
TO GND & TUNING CAP ROTOR
TO TUNNEL DIODE & TUNING CAP STATOR
2
3
4
1
6
5
INTERNAL JUMPER
BOTTOM VIEW OF COIL FORM BASE (AMPHENOL 24-6)
a
3/8" RADIUS
2"
N° 18 ENAMELLED OR BARE WIRE
3/8"
SLIP ENDS INTO PINS 2 & 4 OF COIL FORM & SOLDER
b

Fig. 2—Details of dip-meter coils: a—coils B, C and D; b—coil E.

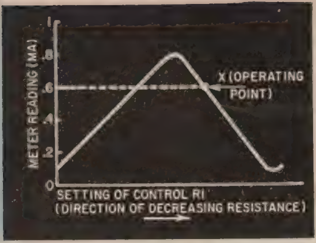


Fig. 3—Meter reading vs R1 setting.

by this type over a long operating life. However, the cheaper, more readily available size-D flashlight cell also operates the circuit, but requires more frequent resetting of R1.

To limit the number of components and conserve space, no on–off switch, as such, is used. Instead, the battery is connected through two terminals of the coil socket, and the corresponding spare pins of each coil form are connected by a wire jumper inside the form so that plugging in the coil switches on the instrument.

Unlike the sensitivity control in tube or transistor type dip oscillators, R1 in this circuit does not have to be reset as capacitor C is tuned through its range—the meter deflection is constant. The operator need only set R1, for circuit oscillation and need only reset it occasionally.

The tunnel-diode dip meter is used in the same way as other dip meters. This technique is so well known and has been explained in so many other places that it needs no repetition here. (See, for example, the author's book *How to Use Grid-Dip Oscillators*, Rider, 1960.)

The instrument is sensitive and deflection is good—the dip is about 50 μa, which is one division on the 1-inch 1-ma meter used. But this is only about 1/16 inch, so sometimes you must watch closely to keep from missing it. (This does not mean the circuit is insensitive but simply that the meter scale is short. On the scale of a 3-inch meter, the same dip looks huge.) A somewhat bigger dip may be obtained by using an rf meter across the tank circuit (LC) instead of the series dc milliammeter. The rf meter circuit consists of a 0–50 dc microammeter shunted by a 1N34 diode, the combination being coupled through a capacitor to the tank coil. This scheme is used in many transistor dip meters. But the rf meter loads the tank and broadens the tuning. It also requires a more expensive microammeter, a second diode and a capacitor. So for our money we give the nod to the simpler, cheaper, sharper-tuning dc milliammeter scheme.

Construction

The photos show structural details of the instrument. Components have been placed for efficient circuit operation, easy replacement and maximum utilization of space.

The six-pin miniature coil socket (Amphenol 78-S6S) is mounted, by its toothed retaining ring, in the nose end of the box. R1 is mounted in the rear end. Meter M is mounted, through a 1⅛-inch hole on the top of the box near the rear end, and tuning capacitor C 1½ inches in from the nose end, to clear the coil socket and allow room for a large knob.

Coil Table

Coil No.	FREQUENCY RANGE (mc)	Specifications
A	1.5–5.5 mc	135 turns No. 32 enameled wire closewound on outside of ¾-inch diameter coil form.
B	4.7–18 mc	1¼-inch length of No. 432T AirDux coil stock.
C	12–45 mc	1-inch length of No. 416T AirDux coil stock.
D	43–160 mc	3 turns of No. 416T AirDux coil stock.
E	150–260 mc	Single hairpin loop of No. 18 bare or enameled wire.

Parts are located to keep leads short and the unit compact. Resistors R2 and R3 are held by a two-lug terminal strip fastened to the inside rear end of the case just below R1. The battery holder is supported behind the meter by a 2-inch 6-32 screw extending from the front panel (top of case). The tunnel diode was not soldered into the circuit, but its cathode pigtail is held by one stator screw of the tuning capacitor, and its anode pigtail by the negative screw terminal of the meter. (Do not solder the diode into the circuit unless you use extreme care and provide a good heat sink.) Be sure the diode is poled correctly in the circuit, with respect to its anode and cathode pigtails. Keep all leads short.

The coils use miniature ¾-inch diameter, 6-pin, plastic forms. For efficient operation in dip-meter applications, the top (leading end) of the coil must be the hot end. Therefore, the top (Fig. 2-a) is connected to pin 4 of the form, and the corresponding pin 4 of the coil socket is connected to the tunnel diode and stator of the tuning capacitor. In each coil form, pins 1 and 5 must be connected together by a short wire jumper for battery switching. Only the A-coil (1.5–5.5 mc) is hand-wound on the outside of its form. The others consist of lengths of prewound Air Dux coil stock (coil E is a hairpin) and are mounted inside the forms. Air Dux comes in 2-inch lengths. Measure off the amount you need (as specified in the coil table), peel off enough wire at each end for leads, pass the top lead down through the exact center of the coil (Fig. 2-a), pass the two leads through pins 2 and 4, respectively, of the coil form, and solder to the pins. The soldering must be done quickly or the plastic form will melt. Fig. 2-b shows details of the 150- to 260-mc coil. After forming this loop, slip its ends into pins 2 and 4 (feeding the wire exactly to the ends of the pins) and solder.

Initial adjustment

Do not install the battery until the wiring has been verified. Afterward, test the instrument in the following manner: Set R1 to its highest resistance. Install the battery. Plug in a coil. Slowly adjust R1, turning it in the direction of decreasing resistance. Note that the meter begins reading and, as R1 is advanced, the reading increases (Fig. 3) to a peak in the vicinity of 0.8 to 1 ma. As R1 is advanced farther, the reading starts decreasing with rotation. The diode now is in its negative-resistance region and is oscillating. Stable oscillation occurs at about 0.6 ma along the negative-resistance slope of the characteristic, but this varies with individual diodes. By experiment, find the point at which the diode does not pop out of oscillation, and at which oscillation occurs immediately when a coil is plugged in—no readjustment of R1 being needed. Couple the dip-meter coil to the coil of a cold, tuned circuit resonant anywhere in the frequency range of the meter coil. Tune the dip meter, watching for a dip in the meter deflection.

Calibration

On each of its ranges, the dip meter should be calibrated at as many points as practicable. During this process, a dial for tuning capacitor C may be prepared to read direct in megacycles.

There are several well known methods of calibrating a variable-frequency oscillator of this type. The most popular consists of zero-beating the dip oscillator against a signal generator at a number of test frequencies, using a simple nonoscillating monitor (such as a 1N34 diode and headphones) as the zero-beat indicator. The second method consists of zero-beating the dip oscillator against a calibrated oscillating receiver, using the loudspeaker or headphones of the receiver to indicate zero beat.

The dip meter may be calibrated also by coupling a signal generator to it (through a single-turn coil connected to the generator output and loosely coupled to the dip-meter coil) and using the milliammeter in the dip meter as a visual indicator of zero beat. (The pointer of the meter will pulsate to indicate the beat, the pulsations slowing to a stop at zero beat.) END

Transistor Tuners for TV

what makes them tick?

By E. D. LUCAS, JR.

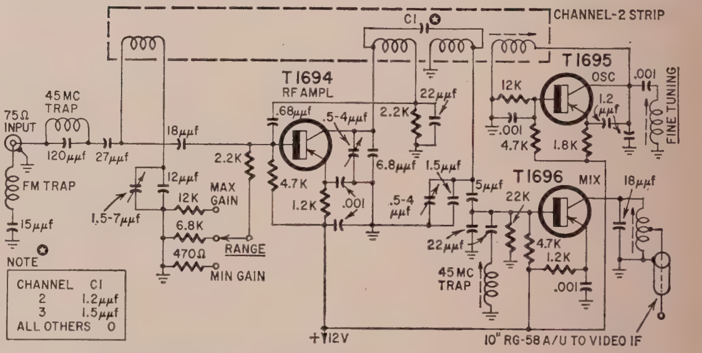

CHANNEL-2 STRIP
C1 ✪
T1694
RF AMPL
T1695
OSC
T1696
MIX
75Ω INPUT
45MC TRAP
120μμf
27μμf
FM TRAP
15μμf
18μμf
1.5-7μμf
12μμf
12K
MAX GAIN
6.8K
RANGE
470Ω
MIN GAIN
2.2K
.68μμf
4.7K
1.2K
.001
.5-4μμf
6.8μμf
2.2K
22μμf
1.5μμf
.5-4 μμf
5μμf
22μμf
45MC TRAP
22K
4.7K
1.2K
.001
12K
.001
4.7K
1.8K
1.2 μμf
.001
FINE TUNING
18μμf
+12V
10" RG-58 A/U TO VIDEO IF
NOTE ✪
CHANNEL C1
2 1.2μμf
3 1.5μμf
ALL OTHERS 0

Fig. 1—Early turret type transistor tuner designed by Philco.

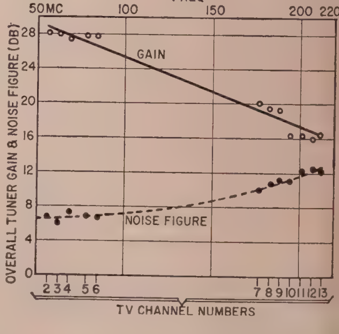


Fig. 2—Overall tuner gain and noise figure for the unit shown in Fig. 1.

As the art of making transistors which operate efficiently at ever higher frequencies has advanced, it is not surprising that circuit designers are using devices such as the Philco MADT and Motorola Mesa transistors in commercially practical TV tuners. This article describes an early experimental tuner with three transistors designed by Philco to prove feasibility; a production tuner, the Mark VI model manufactured by F. W. Sickles Div., General Instrument Corp., and its improved successor recently developed by Sickles and the Lansdale Div., Philco Corp., and another transistorized tuner now in production by Standard-Kollsman Industries, Inc.

To compare this new transistor circuitry with the latest vacuum-tube tuner, there is also a brief discussion of a new Standard miniature tuner which incorporates RCA nuvistor tubes.

About 2 years ago, Philco engineers began working seriously on transistor TV receivers, including vhf tuners. They also designed FM tuners using T1694, T1695 and T1696 MADT transistors. The gain of the early transistor TV tuner design approached that of a commercial tube type tuner, while the noise figure was only slightly higher.

Fig. 1 is a single-channel circuit of this experimental Philco tuner. The Lansdale engineers began by taking a Standard model GG-4200 vhf tuner, removing the tubes and most other components, but retaining the turret and most of the coils. The rf signal from the antenna is shown entering via a 75-ohm coaxial cable, with an FM trap to ground and another 45-mc trap in series with the input circuit to the base of the T1694 transistor.

Note that this rf amplifier uses a common-emitter circuit with fixed neutralization, the output signal from the collector being coupled inductively and injected into the base of the mixer. The local oscillator signal is also coupled into the mixer base.

According to C. R. Gray of Philco, "It has been found that emitter injection provides slightly higher mixer conversion gains. However, it is difficult in a turret type tuner to use emitter injection because of unwanted coupling through the coils. Our experience indicates that incremental type tuners are more effective when using emitter injection. It will also be noticed that there is a 45-mc series trap to ground on the base of the mixer. This substantially increases conversion gain by eliminating 45-mc degeneration in the mixer."

In this design, the local oscillator transistor was specified to deliver a minimum of 1.5 mw of power at 257 mc (for channel 13). The mixer was planned to deliver high conversion gain with a minimum of 1.0 mw of power injected by the local oscillator. Fig. 2 shows overall gain and noise figures for this experimental tuner. Note that gain averaged about 28 db for the low-band vhf channels and the noise figure for these channels (2 through 6) was approximately 7 db. But, on channel 13 the gain dropped to 17 db and the noise figure rose to 13 db.

A still earlier Philco transistor tuner had a common-base rf amplifier with fixed neutralization, through a 0.68-$\mu\mu$f capacitor from the collector to the emitter in this case. (Note that the same size capacitor between collector and base is used for neutralization in Fig. 1.) This preliminary design also had a common-base local oscillator, and both the amplified rf and oscillator signals were applied to the base of the common-emitter mixer.

Note that the tuner in Fig. 1 has a manual gain switch. The three resistors selected by the RANGE switch are used for base bias. A more recent version of this Philco design has forward agc applied. That is, the connection between the lower end of the 1,200-ohm resistor in the emitter circuit of the rf amplifier and the lower end of the 4,700-ohm resistor in the base circuit is broken, and agc voltage is applied through this latter resistor. Also the 2,200-ohm resistor and the three resistors of the RANGE switch are omitted in this design.

Forward agc uses a bypassed resistance in the collector circuit. When base bias is increased, collector current increases and thus the collector-to-emitter voltage goes down. Fig. 3 shows a typical gain characteristic of this rf amplifier when operated at 213 mc under forward agc, with a 2,000-ohm resistor in series with the collector lead, like the 2,200-ohm resistor shown between the collector and ground in Fig. 1.

Sickles Mark 6T tuner

Somewhat similar design logic appears in Fig. 4, the circuit of the Mark 6T transistor tuner developed by Sickles. The antenna input is 75 ohms unbalanced since this tuner is designed for use with a whip antenna on a portable TV receiver. There is an if trap and then a group of antenna coils selected by the switch, with channels 2 through 6 also having a gimmick loop for better image rejection in the input circuit of the rf amplifier.

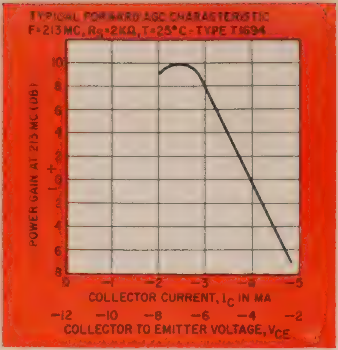


Fig. 3—Gain characteristic of T1694 transistor operated with forward agc.

Here neutralization is provided by a variable capacitor. The amplified rf output is coupled to the mixer base through pairs of coils on the turret for each channel (note CHAN 13 PLATE and CHAN 13 GRID in Fig. 4), again with a gimmick loop being used on the low-band channels. This mixer base, like the Philco model, has an if trap to ground.

However, the Sickles tuner uses a T1597 common-base local oscillator, with selectable and tunable oscillator coils in the collector circuit. The local oscillator output is from the emitter and this oscillator signal is injected into the mixer base.

The mixer is a common-emitter type, with its output—the desired if signal—appearing at the collector terminal and then going to the tunable if coil as shown.

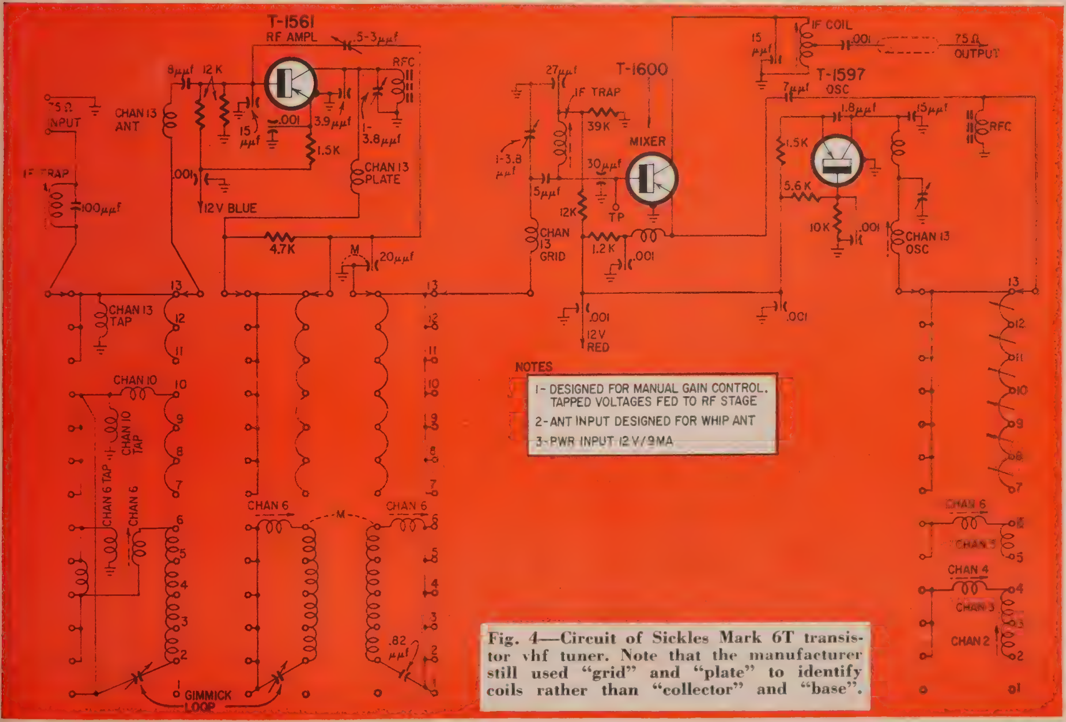
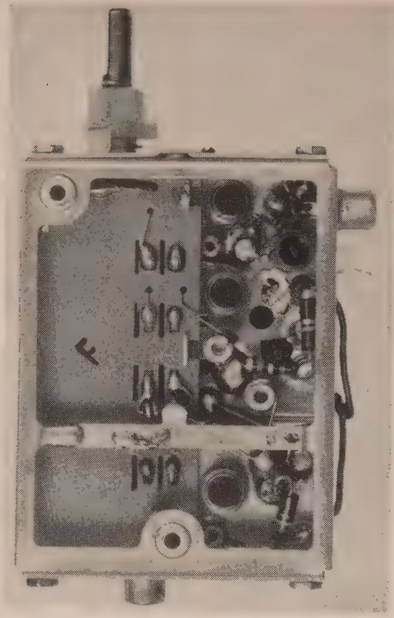
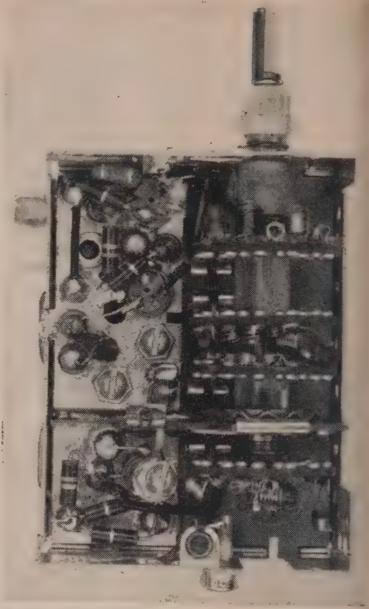

T-1561
RF AMPL
.5-3$\mu\mu$f
8$\mu\mu$f
12 K
RFC
75Ω INPUT
CHAN 13 ANT
15 $\mu\mu$f
.001
3.9$\mu\mu$f
1-3.8$\mu\mu$f
1.5K
CHAN 13 PLATE
IF TRAP
100$\mu\mu$f
.001
12V BLUE
4.7K
M
20$\mu\mu$f
CHAN 13 TAP
CHAN 10
CHAN 10 TAP
CHAN 6 TAP
CHAN 6
GIMMICK LOOP
CHAN 6
CHAN 6
.82 $\mu\mu$f
27$\mu\mu$f
T-1600
IF TRAP
39K
MIXER
1-3.8 $\mu\mu$f
30$\mu\mu$f
5$\mu\mu$f
12K
TP
CHAN 13 GRID
1.2 K
.001
.001
12 V RED
.001
15 $\mu\mu$f
IF COIL
.001
75Ω OUTPUT
T-1597
OSC
7$\mu\mu$f
1.8$\mu\mu$f
15$\mu\mu$f
RFC
1.5K
5.6 K
10 K
.001
CHAN 13 OSC
CHAN 6
CHAN 5
CHAN 4
CHAN 3
CHAN 2
13
12
11
10
9
8
7
6
5
4
3
2
1
NOTES
1- DESIGNED FOR MANUAL GAIN CONTROL. TAPPED VOLTAGES FED TO RF STAGE
2- ANT INPUT DESIGNED FOR WHIP ANT
3- PWR INPUT 12 V/9MA

Fig. 4—Circuit of Sickles Mark 6T transistor vhf tuner. Note that the manufacturer still used "grid" and "plate" to identify coils rather than "collector" and "base".



Top view of the Sickles Mark 6T TV tuner.



Bottom view of the Sickles Mark 6T TV tuner.

Typical measurements applicable to the Sickles Mark 6T are in Fig. 5. Note that gain on the low vhf channels ranges from 29 to 34.5 db and on the higher channels from 21.5 to 24 db. Hence this tuner represents a considerable improvement in gain, as compared with the earlier experimental Philco unit. There is also a substantial reduction in noise, with figures between 4.8 and 5.3 db for the low vhf channels and 9.1 to 10.4 db for the upper band. Image rejection ranges from 62 to 80 db, while if rejection is specified and measured to exceed 70 db, and VSWR is lower than 3 to 1 on all channels. Oscillator radiation is held at about half the limits specified by the FCC.

The gain applied to this tuner is manually controlled by tapped voltage through the lead marked "12-volts blue" in Fig. 4. However, the manufacturer also has models available with either forward or reverse agc, depending on the circuit requirements of the TV receiver in which the tuner is used. As indicated, the Mark 6T draws 8.5 to 9 ma at 12 volts, although a negative 12-volt supply may be used with some circuit modifications.

Fine-tuning range of this Sickles model averages from approximately 3 to 5.5 mc, and the if bandwidth is about 2 mc at the 3-db points.

Recent additional development work performed jointly by engineers of Sickles and the Philco-Lansdale Div. has resulted in the design of tuners with still further improvements in characteristics—they used new Philco MADT germanium transistors having extremely low noise figures. For example, the best units, showing a noise figure of only 2.6 db at 200 mc, are used in the modified Sickles Mark 6T tuner. Their success is indicated in the gain and noise figures plotted in Fig. 6. Note that the highest noise figure—for channel 13, as might be expected—is only 4.6 db. This is lower than the lowest average noise figure for channel 2 in the standard Mark 6T tuner of Fig. 5!

Similarly, with MADT transistors, gain has been improved markedly, ranging from 32 db (channel 13) to 45 db (channel 2). According to the engineers who developed the improved tuner, these advances in gain and about a 2-to-1 reduction in noise figures have been achieved while preserving the useful overload and agc characteristics.

Next month we will conclude this article with a detailed description of the Standard Coil transistor tuner and their nuvistor tuner. TO BE CONTINUED

CH. NO.	NOISE FIGURE (DB)	GAIN (DB)	IMAGE REJECT (DB)	IF REJECT (DB)	FINE-TUNE RANGE (MC)	VSWR		OSC RADIATION (μV/M)
						PIX	BEST	
2	4.8	34.5	62.0	>70	3.1	2.4	1.8	N.L.
3	4.8	32.5	75.0	>70				N.L.
4	5.2	31.8	80.0	>70	3.5	2.4	2.2	10
5	5.3	30.0	80.0	>70				15
6	5.2	29.0	70.0	>70	4.2	1.8	1.8	20
7	9.1	24.0	63.0	>70	5.5	2.2	2.2	49
8	9.9	23.2	70.0	>70				55
9	9.9	22.8	75.0	>70				70
10	10.1	22.4	78.0	>70	4.9	2.8	2.5	42
11	9.8	22.0	78.0	>70				77
12	10.1	21.8	80.0	>70				60
13	10.4	21.5	80.0	>70	3.8	2.4	2.0	75

Fig. 5—Typical specifications for Sickles transistor tuner.

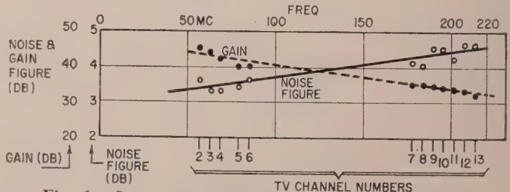
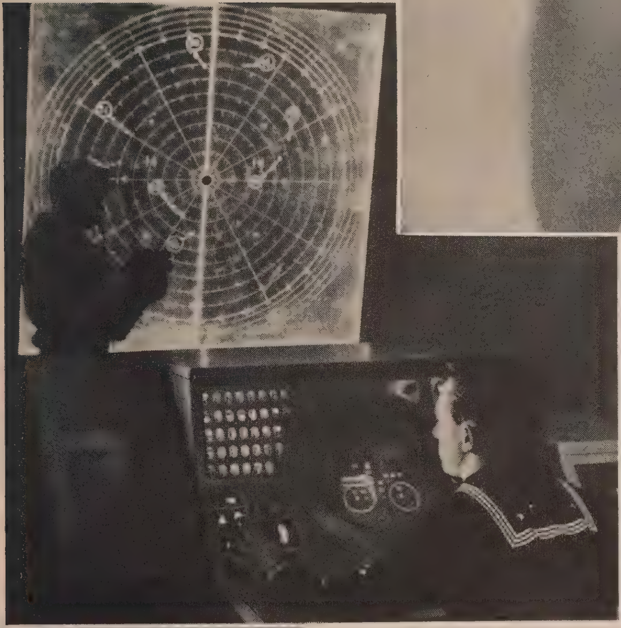


Fig. 6—Gain and noise figure of the Sickles tuner.

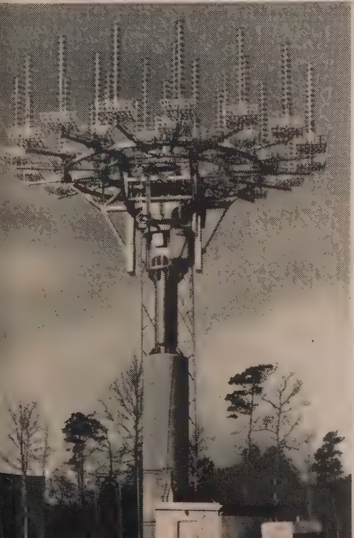
WHAT'S NEW

SIAMESE-TWIN TRANSISTOR—two silicon units with a common collector in one package—is well suited for dc-to-ac conversion. A typical application for this RCA device will be to step up the standard 12-volt dc auto battery to 117 volts to operate common electrical devices.



BATTLE DATA DISPLAY consoles to be installed aboard the Navy's newest aircraft carriers and missile ships will give a quick graphic picture of the task force's entire tactical situation. The displays make it possible for the commander to have a minute to minute picture of the situation and concentrate on coordinating the operation, according to Hughes Aircraft, which makes the equipment.

LUMINESCENT READOUT LAMPS are designed to display letters and words on stock quotation boards, time and temperature indicators, travel schedule indicators and similar devices. The large 4-inch-high letters can be read at distances up to 150 feet. The Rayescent panels are made by Westinghouse.



END-FIRE ANTENNA at Wallops Space Flight Station will be used to receive telemetry information from rockets being tested at the Virginia installation. Designed and built by CB Electronics Corp., Valley Stream, N. Y., the antenna has 33 end-fire elements.

TROUBLESHOOTING POWER SUPPLIES WITH A SCOPE

If you can see what's wrong in the power supply, it's a lot easier to fix it

By ROBERT G. MIDDLETON

WE find highly informative — and sometimes rather surprising — waveforms in power-supply circuits. Sometimes we can find things here at the source of the receiver's power that can save us time troubleshooting further along in the circuitry.

Before starting out on this type of troubleshooting, only one caution is necessary. *Do not confuse power-supply trouble* with symptoms of excessive current drain caused by some circuit beyond the power supply. If one of the circuits in the receiver is drawing excessive B-plus current, ripple voltage is bound to increase. If the normal current drain for the piece of equipment is not given in the service data, it is sometimes possible to make a comparison measurement on another receiver of the same type. Failing that, crude calculations based on Ohm's law may help to determine if current drain is normal. And of course the usual technique of looking, feeling and smelling (combined with a few voltage measurements) will show up components drawing too heavy currents, as well as open ones.

Fig. 1-a, below, is the circuit of a simple half-wave power supply. Fig. 1-b is the voltage across the input filter capacitor. Normally this waveshape is a sawtooth. This is because the input filter capacitor charges in current *pulses* at the positive peak of the ac voltage, and discharges more slowly between these pulses.

Also shown—in Fig. 1-c—is the normal waveform across the output filter capacitor. The waveshape looks like this because the 1,200-ohm filter resistor and 30-μf output capacitor form an integrating circuit. When a sawtooth wave is integrated, it is changed into a parabola.

Such filter waveforms and normal peak-to-peak voltage values are often specified in receiver service data. This makes it easy to determine if there is trouble in the power supply.

We can check the current from the line into the rectifier with a scope. Connect a small resistor in series with the plate lead of the tube. (This is often a surge resistor already in the circuit.) Put the scope across the resistor (39 ohms in Fig. 2.) Then the current waveform appears as in Fig. 3. The current flows in pulses (the current waveform is *not* a sine wave).

The four waveforms in Fig. 3 are all the same. They look different because the horizontal and vertical gain controls of the scope were set to different positions for each photo. We see that we must get used to *apparent* changes in

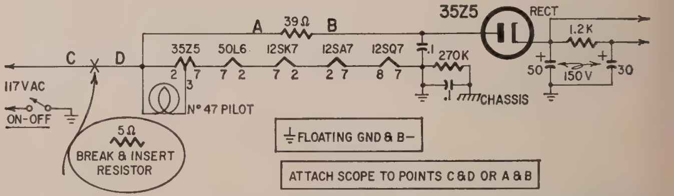


Fig. 2—Scope is connected between A and B to see current waveform into 35Z5. To see total current waveform (heaters and B-supply) connect scope between C and D.

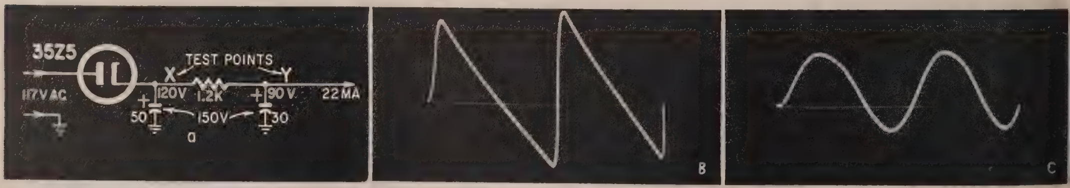


Fig. 1-a—Simplified halfwave supply; 1-b—waveform from X to ground; 1-c—waveform from Y to ground.

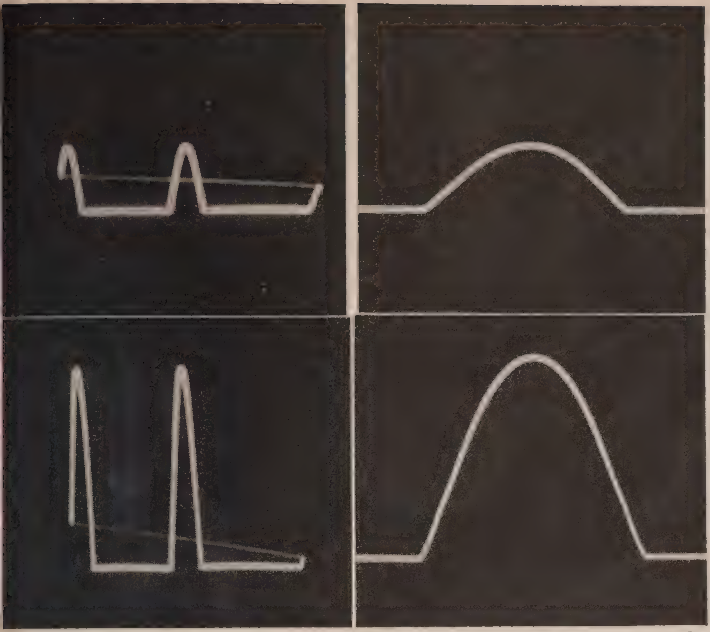


Fig. 3—Scope adjustments can make one waveform look like four. Top two are taken with scope's vertical gain low. Bottom two, same waveform, but with scope's vertical gain turned up.

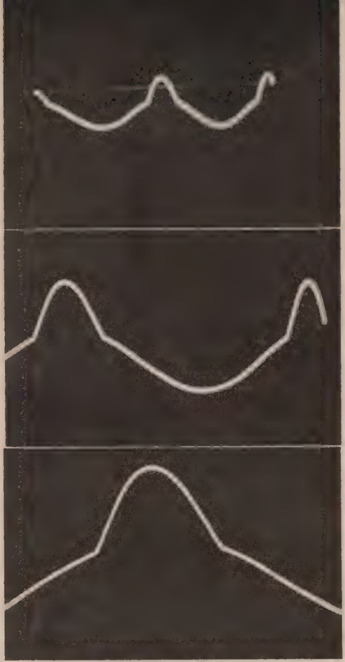


Fig. 4—Current waveform combines heater sinewaves and rectifier pulses: top—horizontal and vertical gain low; middle—vertical gain high; bottom—both vertical and horizontal gain high.

waveshape caused by different settings of the scope controls.

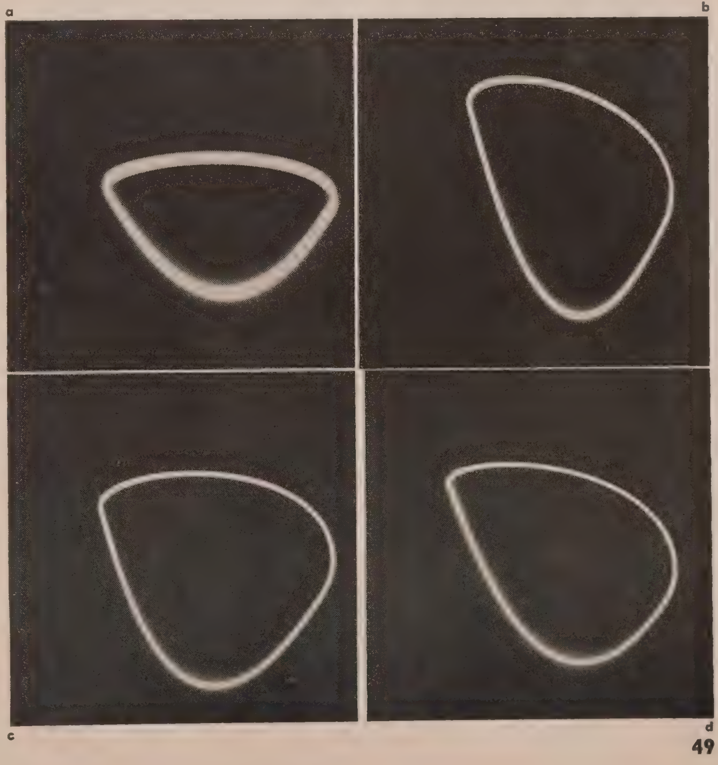
Next, if we wish to see the *total* current waveform, we connect the scope next to the line input (insert a 5-ohm resistor and connect the scope across it, as in Fig. 2). The scope pattern then shows the combined heater and power-supply current. The current waveform is shown in Fig. 4.

Cyclograms can often give useful information on power-supply defects. A cyclogram is the pattern displayed when the vertical input terminal of the scope is connected to the input side of the power supply and the horizontal input terminal connected to the supply's output side. Of course, it is necessary to make sure that the grounded terminal of the scope is connected to the grounded side of the power supply.

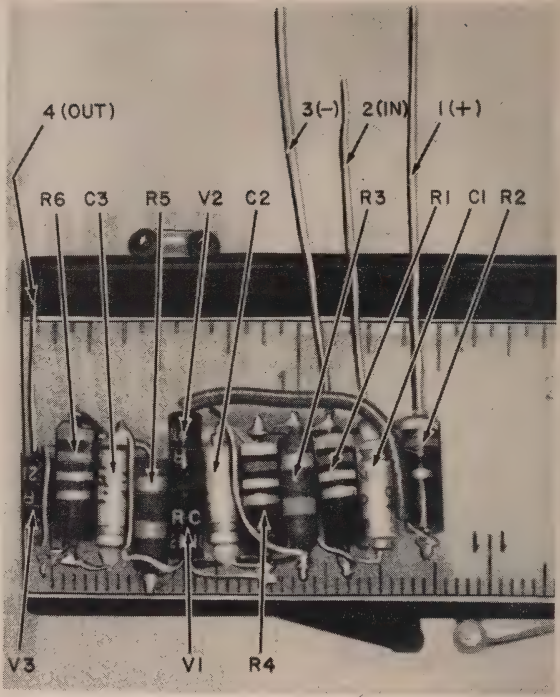
Fig. 5 shows typical cyclograms for the power-supply circuit of Fig. 1-a. The waveform of Fig. 5-a is that of a normal power supply. Fig. 5-b is what may appear if the output capacitor has lost capacitance. The cyclogram is also distorted if the input capacitance goes down (Fig. 5-c). And when both input and output capacitors are low, the scope will show the pattern of Fig. 5-d.

Once you have reason to believe trouble may be in the power supply, these techniques can be very helpful. You will find that the scope can be as useful and save as much time here as in shooting trouble in any other part of the set. END

Fig. 5 (right)—How a cyclogram can show up weaknesses in a power supply. Lack of capacitance in either or both capacitors shows up at once.



MINI-PACK AMPLIFIER YOU CAN MAKE



Back view of the amplifier. A strip of cellophane tape forms the chassis. RCA 2N105's, now unavailable, were used in this version of the Mini-Pack.

By **FORREST H. FRANTZ, SR.**

3-transistor unit has a gain of 72 db, yet costs only about $10

THE big things in electronics are the things that are getting smaller. The audio amplifier is one member of the family of electronic items growing by collapsing in size. The Centralab TA-11 and TA-12 packaged amplifiers introduced within the last couple of years have been among the greatest advances in audio-amplifier miniaturization in recent years. The TA-11 is only 1.175 x 0.665 x 0.25 inch, has a gain of 73 db and operates from a 1.5-volt battery with a current drain of about 4 ma. Unfortunately, it is no longer made. But it has been replaced by the TA-12, which is only 0.531 inch in diameter and 0.228 inch thick, has a gain of 73 db, operates from a 1.5-volt battery and draws about 1.6 to 2.2 ma. Both are naturals for the experimenter. But, the high cost (about $30 for the TA-11; $45 for the TA-12) precludes their use by many. I've enjoyed experimenting with the TA-11 so much that I decided to try to fabricate a less expensive amplifier unit, using more conventional parts, that wasn't too much larger. The results were more than gratifying.

The Mini-Pack amplifier is so small that I continually lose it on my desk. Mine measures 1.5 x 0.2 x 0.7 inch. Yours can be as small as 1.4 x 0.15 x 0.55 inch if you're very careful with the construction. It's not as compact as the commercial units just mentioned, and it certainly isn't as rugged. But the Mini-Pack amplifier is rugged enough to withstand moderately rough treatment.

The Mini-Pack parts cost is very low: three transistors, three ultraminiature capacitors, and six ½-watt resistors are the only parts required. Their total cost is about $10. At this price, anyone can get in on the fun of building the numerous pieces of miniature electronic gear that have been described in RADIO-ELECTRONICS.

Construction is simple and quick. No specialized printed-circuit techniques are employed. But the construction differs from conventional assembly in that there is no component mounting board or chassis. The amplifier is constructed by mounting the components side by side on a piece of cellophane tape. When wiring is completed and the unit has been checked, the entire assembly is encapsulated with a coat of Duco cement.

Circuit and performance

The Mini-Pack amplifier is a three-stage grounded-emitter amplifier employing high-gain, compact 2N207 transistors (Fig. 1). The small size of the 2N207 makes it an ideal choice for the Mini-Pack. The first 2N207, V1, has a 47-ohm emitter-bias stabilization resistor. In addition to stabilizing V1's dc operating point, this resistor increases the amplifier's ac input impedance to approximately 2,000 ohms and improves the stage's frequency response. The emitters of the two other amplifier stages are returned directly to ground.

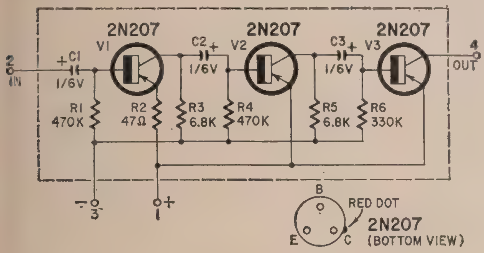
Coupling between stages is conventional and no stabilization is provided in the base circuits. Further stabilization was avoided because the additional resistors would have increased the size.

The gain of the amplifier is 72 db at 1,000 cycles with a 1.5-volt battery. Current drain is 0.6 ma. With a 3-volt battery, the gain is 81 db at 1,000 cycles and current drain is 1.2 ma. The amplifier response is ±5 db from 50 to 10,000 cycles. These measurements were made with a 1,000-ohm headphone connected as a load.

The amplifier can drive a loudspeaker through a suitable output transformer (1,000 ohms to voice coil) but the output level is low. The amplifier was designed for use with headphones. If you use it this way, you'll get best results.

How can you use it?

I've pointed out that you can use this amplifier for some projects that have been described in previous issues of RADIO-ELECTRONICS. To get a feel for how the Mini-Pack can be used, see Fig. 1. Note that the Mini-Pack has only four leads. The volume control is connected in the amplifier input circuit to make this small number of leads possible. Fig. 2-a shows the circuit of a transistorized hearing aid using the Mini-Pack. Fig. 2-b shows the complete circuit of a Mini-Pack radio. You can apply the Mini-Pack to numerous other miniature electronic equipment ideas.



R1, R4—470,000 ohms
R2—47 ohms
R3, R5—6,800 ohms
R6—330,000 ohms
All resistors ½-watt 10%
C1, C2, C3—1 μf, 6 volts, ultraminiature electrolytics (Barco P6-1 or equivalent)
V1, V2, V3—2N207, Philco

Fig. 1—Circuit of 3-transistor amplifier.

When using the Mini-Pack in electronic circuits, keep leads as short as possible. Long leads may cause oscillations due to feedback from output to input leads. They may also cause oscillations due to long common paths since the Mini-Pack battery input isn't bypassed, and you may get hum if you have long leads in this high-gain amplifier's input circuit. Feedback from output to input can also result if input and output leads are too close to each other. This is why V3's collector is located so far from V1's input.

Construction

It's simple indeed to build a Mini-Pack amplifier. The photos show front and back wiring. Start by connecting R6, C3 and V3's base together. Then work your way forward, wiring toward the input end of the circuit. Keep the parts close to each other and the leads short. Complete all wiring except connections to the battery. All connections are made with parts leads. None of the leads, except V1's emitter lead, need be insulated if you dress them carefully to avoid shorts.

When all connections except for the battery have been made, place a piece of cellophane tape against the back of the amplifier. This piece of tape is an insulator. Connect the unwired ends of R6, R5, R4, R3 and R1 together, using a length of No. 28 insulated magnet wire. This connects the battery minus circuit to the full-length R1 lead which is lead No. 3 of the Mini-Pack.

Next, connect the emitters of V2 and V3 and a piece of magnet wire together. Connect the other end of the magnet wire to the long end of R2, which is lead No. 1 of the Mini-Pack. Be careful not to burn your insulator (the cellophane tape) when you solder these connections. The positive lead of C1 is lead No. 2 and the collector lead of V3 is lead No. 4 of the Mini-Pack. To complete the job, distribute a small amount of Duco or plastic cement over the parts and wiring. But test its operation first!

Watch the heat!

Use a small hot soldering iron to make connections, and apply heat for as short a time as possible. If you use a soldering gun, let it heat up before you apply it to the work. This way you'll be sure of good connections, and at the same time you won't overheat the transistors or the ultraminiature capacitors. The old trick of using a pair of long-nose pliers as a heat sink is helpful when soldering some of the connections. Use resin-core solder, of course. The Mini-Pack's a fine little electronic gadget, and a little patience during construction will pay off. END

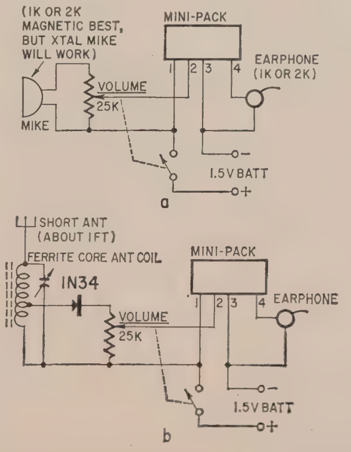


Fig. 2—Two circuits using the Mini-Pack: a—simple hearing aid; b—transistor radio.

Simplified Time-Delay Circuit

R-C time-delay circuits have advantages over thermal time-delay devices in accuracy of timing and the ability to reset for the next cycle instantly. However, if one wants fairly long delays, it is usually necessary to use a very sensitive relay and large capacitor. The advantage of the circuit shown here is that one can use nearly any relay in the junkbox, and the capacitor does not have to be very large for delays of a few seconds or more.

The secret of this circuit lies in the fact that the power supply in used to furnish nearly enough power to operate the relay, and only the balance is supplied by the capacitor. When the pushbutton (S) is pressed, the relay is energized from the dc supply. This closes the lower contacts, providing a parallel path to the relay through R. When the button is released, the time delay begins as power flows both through R and from C, into the relay. After a few seconds, the voltage across C will have diminished to the point where the relay opens, allowing the capacitor to charge up for the next cycle. Changing D changes the length of the time delay.

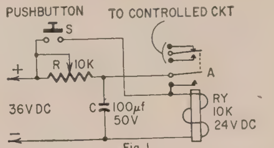


Fig. 1

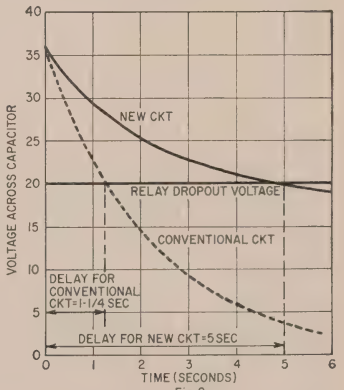


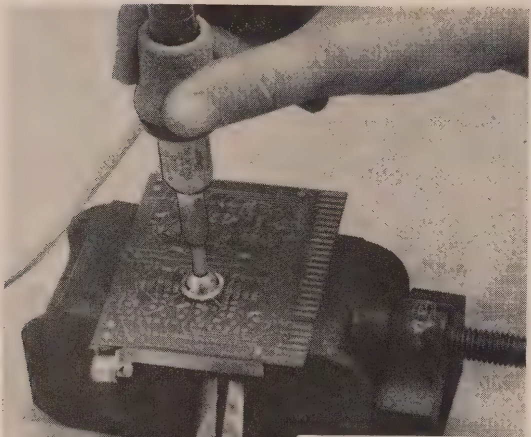
Fig. 2

A relay adjusted for close differential (small change in current between open and close) will provide long time delays even though it is not particularly sensitive.

The relay-capacitor combination shown in Fig. 1 provided delays up to 5 seconds while the same components used in a conventional circuit provided a maximum delay of about 1 second.
—Clark Hamilton

DESOLDERING PRINTED-CIRCUIT BOARDS

By **ALVIN B. KAUFMAN**



Removing a transistor socket with a cup-shaped tip.

REPLACING wiring and components in TV sets, both standard and printed-circuit types, is a familiar problem to all service technicians. When standard wiring was used, the technician would heat the joint and use a screwdriver or long-nose pliers to loosen it. But this won't work on printed circuits.

Semiconductors and miniature components just can't take heat or rough treatment. Then, too, removing items like if transformers and tube sockets by these methods often results in a damaged printed circuit board.

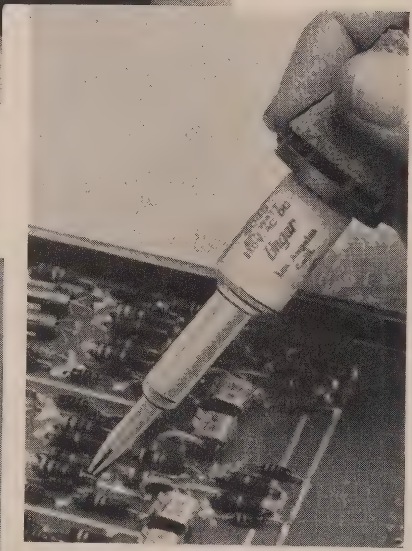
The old techniques also don't work where components with a number of leads have to be removed. Heating each joint individually and prying it free is troublesome and time-consuming.

To beat this problem, several special soldering tips have been developed. The photos show how they are used. One is a straight bar that is handy for removing straight-line components such as ceramic packs of capacitors, resistors, transistors or combinations of these units. Simply heat the terminals and, when the solder loosens, pull the unit free of the board.

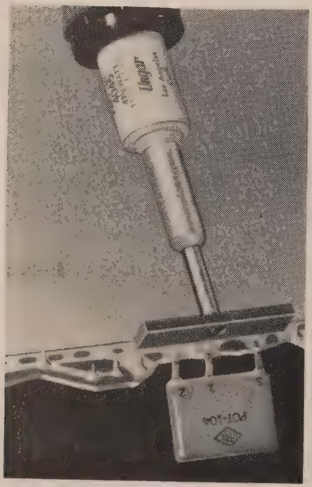
Another unit is a cup-shaped tip. It comes in various sizes and is good for desoldering tube and transistor sockets in one operation. Also, some if and rf coil assemblies can be removed using this tip. Simply place the hot cup over the socket or transformer, and the unit is free.

A third tip that is almost a must for printed-circuit work is a slotted one that is used to heat and straighten hold-down lugs or remove twisted and straight component leads.

Of course, before using any of these tips, they should be tinned and brought to soldering temperature. And any tip used for desoldering can also be used to fasten the new component in place. Touchup work can be done with the edge of a cup or bar tip while the slotted tip can be used like a conventional soldering iron. Learning to use these tips is just a matter or practice. Once you do learn, you'll wondered how you ever managed without them. END

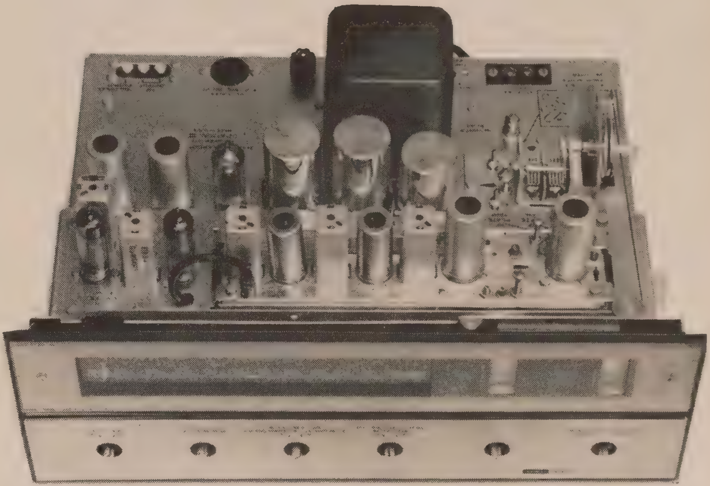


A slotted tip facilitates resistor removal and desoldering of other single-lead connections.



Bar-shaped tip is used to remove in-line components.

CITATION III



An FM tuner kit with some interesting circuitry

By **LARRY STECKLER**
ASSOCIATE EDITOR

Top-chassis view of the completed FM tuner kit.

WITH FM stations steadily on the increase, the demand for FM tuners has also grown. High-fidelity requirements have pushed these tuners into the quality class, and today it is hard to spot the difference between music direct from records and music from an FM tuner.

FM tuners are generally expensive and, in an effort to keep costs low, several manufacturers have turned out FM tuner kits. Such kits can cut as much as $80 off the assembled-unit price.

One of the more interesting of the FM tuner kits is Harman-Kardon's Citation III. Including the rectifier, this set uses 10 tubes and 4 semiconductor diodes. The complete circuit is shown in the diagram. Now let's take a closer look at the interesting features of its circuit.

The signal from the 300-ohm line is fed through a tuned input circuit to the grid of a 6CW4 nuvistor, the first rf amplifier. The nuvistor, a miniature metal-cased vacuum tube about the size of a transistor, provides high amplification with a comparatively low noise level. C6 and L1, between plate and grid, form a neutralizing network.

Note the simple spst RANGE switch incorporated into this circuit. In the DISTANT position, it shorts out a negative bias applied to the grid of the 6CW4 through R8, increasing the triode's gain. In the LOCAL position, some negative bias is applied to the nuvistor grid, lowering the sensitivity of the rf stage. A short length of coax connects the nuvistor output to the prealigned "cartridge." Coil L2 at the nuvistor output and coil L4 at the second rf amplifier input match their respective circuits to the impedance of the line.

The if cartridge

Next of interest is the cartridge that contains the pretuned, prealigned if strip, rf amplifier, mixer, oscillator and part of the afc system. It contains four tubes and one semiconductor diode and is completely prealigned. When the receiver is completed, this feature eliminates any need for tuning the if strip, a difficult (almost impossible) job to do properly unless you have a sweep generator and oscilloscope on hand.

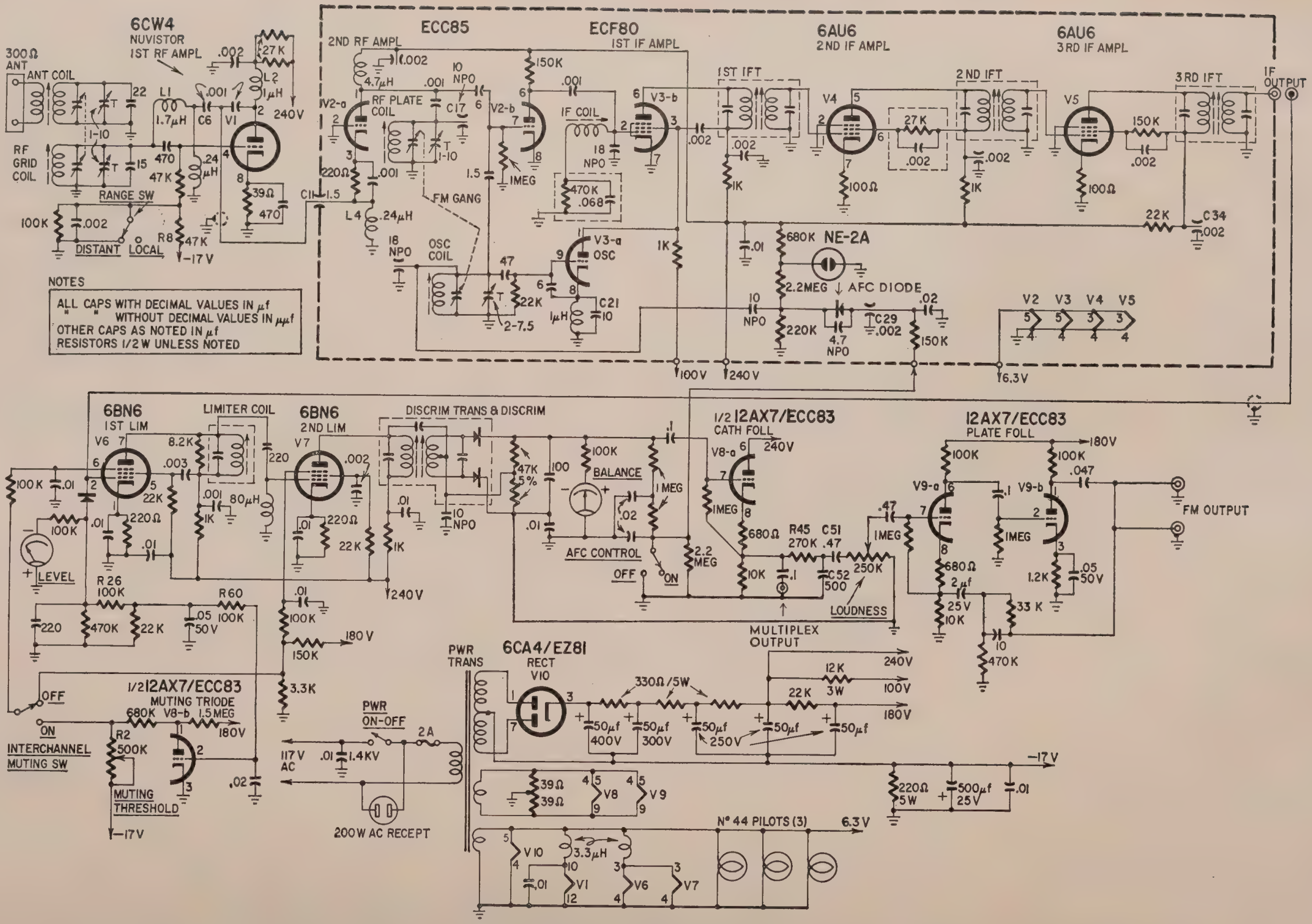
The tuning gang in this tuner is also noteworthy. It consists of two separate small variable capacitors, one in the cartridge in the oscillator circuit, the other on the main chassis in the rf circuit, ganged by a length of dial cord. Both are dual-section units, small in size, and are thus ideally suited for loss-free tuning in the FM band.

The cartridge includes three if amplifier stages tuned to 10.7 mc. They are a bit different from those found in many FM tuners as they are completely free from regeneration.

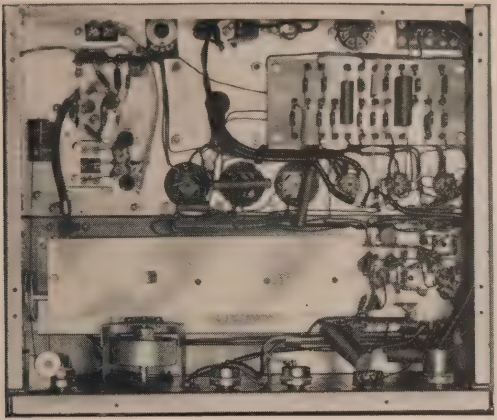
Limiters and muting

The output of the if "cartridge" connects to the rest of the tuner through a phono jack and a short length of coax

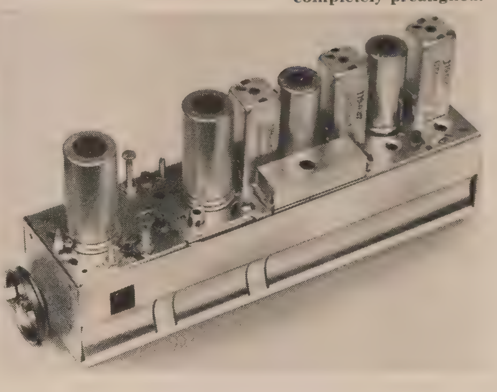
Harman-Kardon Citation III.


6CW4
NUVISTOR
1ST RF AMPL
300Ω ANT
ANT COIL
RF GRID COIL
RANGE SW
DISTANT
LOCAL
L1 1.7μH
L2 1μH
C6
V1
240V
R8 47K
-17V
NOTES
ALL CAPS WITH DECIMAL VALUES IN μf
" " WITHOUT DECIMAL VALUES IN μμf
OTHER CAPS AS NOTED IN μf
RESISTORS 1/2 W UNLESS NOTED
ECC85
2ND RF AMPL
V2-a
RF PLATE COIL
C17
V2-b
FM GANG
OSC COIL
L4 .24μH
C11
ECF80
1ST IF AMPL
V3-b
IF COIL
V3-a OSC
C21
6AU6
2ND IF AMPL
V4
1ST IFT
6AU6
3RD IF AMPL
V5
2ND IFT
3RD IFT
IF OUTPUT
C34 .002
NE-2A
AFC DIODE
C29 .002
V2 V3 V4 V5
100V
240V
6.3V
6BN6
1ST LIM
V6
LIMITER COIL
6BN6
2ND LIM
V7
DISCRIM TRANS & DISCRIM
BALANCE
AFC CONTROL
OFF
ON
LEVEL
R26 100K
R60 100K
1/2 12AX7/ECC83
CATH FOLL
V8-a
R45 270K
C51 .47
C52 500
LOUDNESS
MULTIPLEX OUTPUT
12AX7/ECC83
PLATE FOLL
V9-a
V9-b
FM OUTPUT
180V
1/2 12AX7/ECC83
MUTING TRIODE
V8-b
R2 500K
MUTING THRESHOLD
INTERCHANNEL MUTING SW
PWR ON-OFF
117V AC
200W AC RECEPT
PWR TRANS
6CA4/EZ81
RECT
V10
330Ω/5W
N° 44 PILOTS (3)
-17V
6.3V

Circuit of the 10-tube FM tuner.



Under the Citation III chassis.



The if "cartridge" is completely prealigned.

cable. Here the signal is fed to two 6BN6 gated-beam limiter stages. The first limiter is controlled by a muting circuit that cuts off the tuner whenever no signal is fed to the limiters. This gives silent tuning, no annoying hiss between stations when tuning the receiver. Here's how it works:

A portion of the signal applied to the grid of the first limiter is rectified by a semiconductor diode (off the grid of the first limiter) and passed on through R26 and R60 to the grid of the muting triode. This negative signal keeps the muting triode cut off and the limiters act normally. But when there is no if signal, no negative bias is applied to the muting triode grid. Now the tube conducts and a negative signal feeds through R2 and the muting switch to the limiter quadrature grid. This cuts off the limiter and in this way mutes the audio output of the tuner. This system causes no sharp "thunk" as it cuts in or out, the signal simply disappears or snaps in. Naturally, the muting circuit can be switched out if desired. The MUTING THRESHOLD control sets the cutoff point.

Discriminator and output

Following the limiters is a rather conventional balanced discriminator. Note that the discriminator diodes are inside the can housing the discriminator transformer. But immediately following the discriminator is something different. Instead of the usual de-emphasis network immediately following the discriminator, there is a cathode follower and then the de-emphasis network made up to R45 and C51. This puts the network in a low-impedance circuit and prevents it from having any unbalancing or other effect on the discriminator.

Between the de-emphasis network and the tuner output are two more stages: a two-stage 12AX7 amplifier. Heavy feedback around this "plate-follower" circuit reduces its gain to about 3 and stabilizes the tuner's audio response.

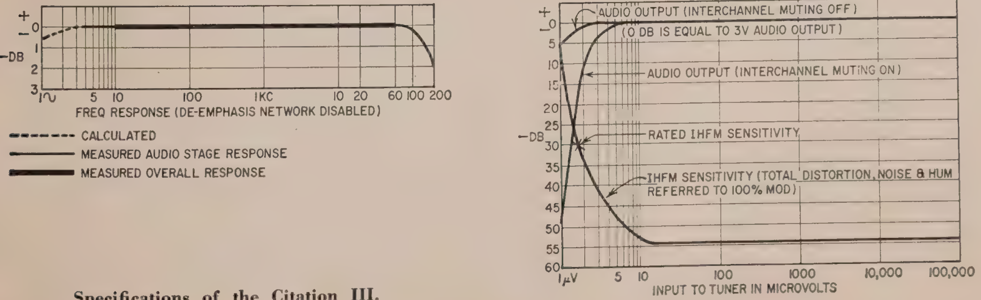
Two meters are built into the tuner circuit. The one following the discriminator is the tuning indicator and is used to check limiter and discriminator alignment during construction. The second meter measures level (signal strength). It is at the grid of the first limiter. Both are highly sensitive 150-μa units.

The tuner's power supply is just as carefully designed as the rest of the unit. It includes five 50-μf electrolytics to keep hum to a minimum.

The tuner includes an afc circuit. It controls the tuner oscillator. Here's how it works: When the AFC CONTROL is in the OFF position, the variable capacitance diode is grounded and has no effect on the oscillator. However, in the ON position, this is no longer true. Now, a portion of the discriminator's dc output biases the diode, varying its capacitance in one direction as discriminator output goes positive and in the other direction as it goes negative. The afc diode (variable capacitor) is effectively in parallel with the oscillator tank circuit, a part of the tuned circuit in the Colpitts type oscillator. Therefore, as the diode capacitance varies, the tuned circuit varies, keeping the oscillator on frequency.

In a final look around the tuner, note the use of feedthrough capacitors in places where they are not normally expected—C17, C34 and C29, for example. Here they are used as bypass capacitors and offer increased performance over standard bypasses as they provide a pure capacitance with minimum stray inductance. Also note the multiplex output jack and the pair of tuner output jacks.

We have seen what Harman-Kardon feels is the works of a high-grade FM tuner. They have put it into kit form to keep the price low and have built in features that make it easy to align without expensive test equipment. END

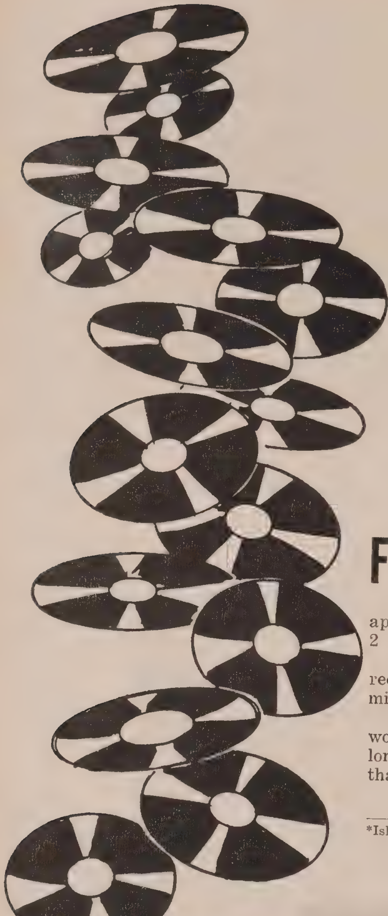


Specifications of the Citation III.

30-day LP record

By MOHAMMED ULYSSES FIPS, I.R.E.*

Remarkable new technique may foreshadow end of recording as we know it today



FOR the editor's birthday I had planned a big surprise—the world's longest playing record!

When flat disc records made their appearance in 1894, they ran about 2 minutes.

Then came the long-playing (LP) record in 1948. This one ran about 30 minutes per side.

Why stop there? For years I had wondered why no one made a *really* long-playing record. I decided finally that what stopped most designers was the *groove system* that somebody dreamed up, probably Edison for his first cylinder record. Later, misguided designers blindly followed the groove idea and stuck in it. Why a groove or channel in this day and age? Must there be a stylus in a groove to wear out the channels in due time? Silly, isn't it? *Why not just a fine threaded groove on a spindle and let the reproducer ride in it?* Then make the record of a magnetic compound similar to today's magnetic tape—but make it ALL magnetic. Now the reproducer no longer need touch the record at all—it floats .0015 inch above it.

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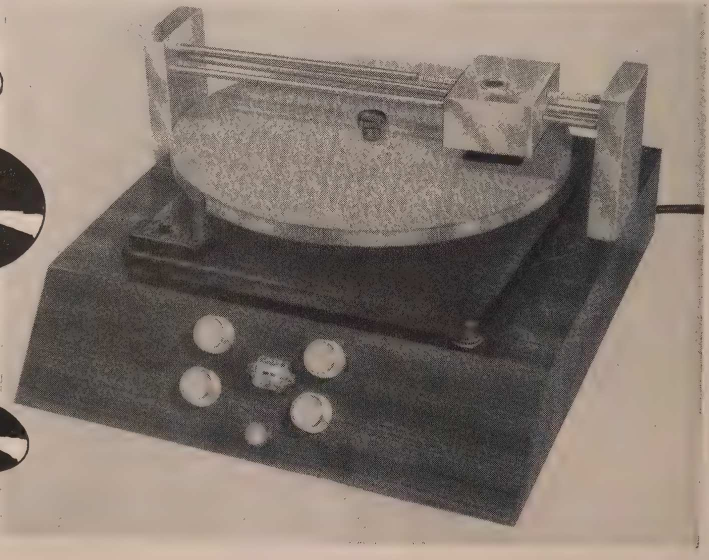
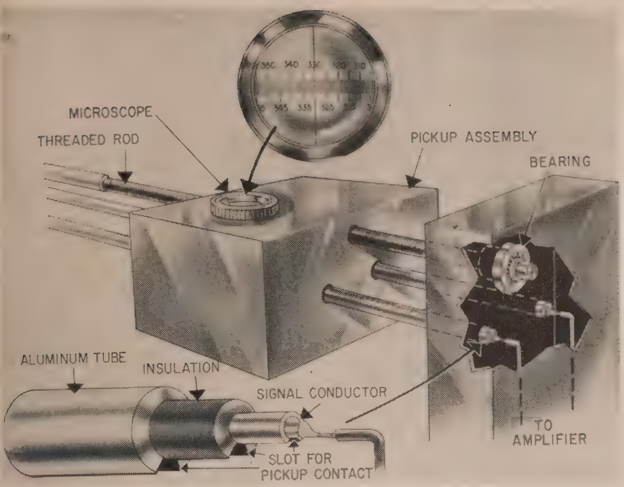
*Islamic Radio Engineers.



The completed 30-day record and player.



Detailed view of the pickup assembly.

The fine threaded spindle which carries the reproducer mechanism also has a reducing gear to suit any required time elapse. This is, of course, nothing new. The same idea is used in certain pocket watches that give the phases of the moon, and even the year—it's all in the watch's reducing gear wheels.

The present-day standard LP record has a groove path about 3½ inches wide. There are about 900 parallel grooves, each about .001 inch wide. (Length of entire groove path: 1,411 feet or 0.267 mile.) That's about as many physical grooves as is possible to cut in the space available.

My new **30-Day LP Record** is made of cast brass for rigidity, coated with a special iron–nickel oxide compound on a base of hard plastics. For the all-important high-polished smoothness of the record surface, which cannot vary more than 1/10,000 inch in thickness, several special oxides have been added to the magnetic nickel–iron layer.

Naturally, the old-style pickup with its monstrously thick needle point that travels in a groove cannot be used with a 30-day LP record.

Something far more sophisticated is needed for my modern magnetic pickup. And here I had to go back to the old detector days of 1914.*

For the historic Electro Importing Co. (E. I. Co.) my boss designed the famed *Radioson* electrolytic detector which, incidentally, was used by the United States Navy for several years. It used an extraordinarily fine, exposed platinum wire point .0001 inch (one-ten-thousandth of an inch) thick. Wollaston wire is made of platinum, coated thickly with silver. It is drawn down till the platinum wire is only .0001 thick. Then the silver is dissolved with nitric acid, leaving the almost invisible platinum wire exposed. This was far too frail to be used in a portable commercial detector.

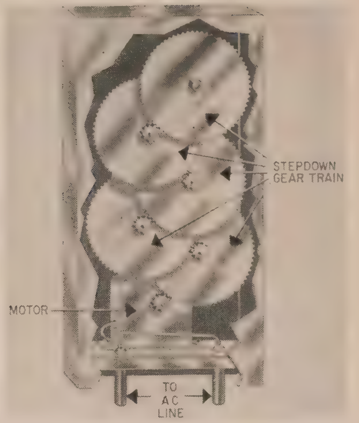
Here for the first time in print I disclose how the vital Radioson detector point was manufactured.

A one-inch piece of Wollaston wire was held by its end in an alcohol burner flame for a few seconds. That burned off the silver. Now the wire was inserted in a glass tube and the fine, bare end of platinum was fused into the glass. When annealed, the fused end of the glass tube was rubbed carefully over a fine-grain Carborundum polishing stone, Under the microscope, the vital point was then inspected and repolished till the face of a perfectly round platinum section could be seen in the microscope field.

This was the heart of the Radioson. It was then fused into a larger glass tube containing diluted sulphuric acid. The hermetically sealed arrangement made one of the most sensitive radio detectors of the period.

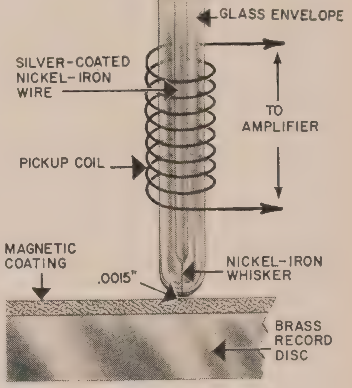
I have chosen a very similar idea in my 30-day LP pickup (see illustrations). *Here, however, I use a magnetic pickup point.* The "wire" in the sealed-off glass tube is a variation of the recently discovered *Whisker*—a metallic crystal 1/20,000,000 inch thick. It is of nickel-iron coated with silver as in the regulation Wollaston wire. The silver is removed, leaving only the nickel-iron core point that now becomes the heart of the pickup.

The pickup travels only .0015 inch above the rotating record disc. The glass tube that holds the nickel-iron wire has a special inductance winding surrounding it, the ends of which are then connected to the amplifier. As the record revolves below the pickup, the magnetic impulses go from the pickup wire to the high-fidelity amplifier, exactly as in the old-time LP record. The pickup travels exceedingly slowly across the record: *it takes 30 days to traverse the distance of 3½ inches across the face of the record.* The threaded spindle is turned at the proper speed by a motor and reducing gears contained in one of the side supports.



Reducing gears bring motor speed down to rotate the threaded rod.

Enlarged diagram of the pickup.



As there are no physical record grooves to contend with, we can now make a recording of a fantastic number of phantom "grooves", in reality, *paths*. Thus, instead of the mere 900 parallel physical grooves of the old LP record, *we actually have 1,152,000 magnetic paths covering 342.7 miles.* (Theoretically, we could have as many as 80,000,000 molecular paths, a total of 23,780 miles. This would give us an LP record running 69 months, or 5 years and 9 months!)

But let us stay with my present 30-day LP record. Which brings me to the question everyone asks: Why such a record at all?

Answer: Why have thousands of records when a few will do? Why clutter your house with a large library of records when a few 30-day LP records will do?

My ambition—when I visualized my

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*See E. I. Co. Catalog No. 12. Also *The Electrical Experimenter*, January 1914, page 144, and February 1914, page 146.

first 30-day record—was to construct a single record disc, *the same size as an old-style one,* on which I could record ALL of Mozart's works.

This sounds impossible if you consider all his operas, sonatas, songs, oratorios, cantatas, concertos and symphonies—a total of over 600 works! Yet that is exactly what I did.

I secured every Wolfgang Amadeus Mozart record I could buy or borrow and recorded ALL of them on a single record. Unfortunately, not all of Mozart's works are recorded on discs or tape—I fell far short of his 625 compositions. Over 50 had to be played for me by a volunteer amateur orchestra to make the record as complete as humanly possible. This took time—8 months of actual recording!

Naturally you will ask who on earth will want to listen to a rendition of all the hundreds of Mozart's works, continuously, day and night for 30 days!

Not so fast, friends. *My* 30-day LP record is something special, not intended to be played uninterruptedly.

Running parallel to the spindle that carries the pickup and its gear works is a micrometrically accurate scale numbered from 1 to 1,000. By lifting the pickup, you can set its pointer on any number you wish.

The instruction card that lists all Mozart's works by key numbers tells you exactly *where* to find each composition on the micrometric scale. Thus the complete opera *The Marriage of Figaro* will be found on 189 of the scale. Set the pickup pointer on 189, and you have the desired work. *Don Giovanni* will be found on 97, and so forth.

The cost of such a record as it will be made commercially may run from $50 to $80—a very low price if you consider that a single record may replace several hundred old-style LP's.

* * *

It was the editor's birthday when I presented him with the finished 30-Day LP record. No one in the organization had had the slightest inkling of my epoch-making invention.

The big boss seemed highly pleased, even fascinated, with it as I explained the whole idea and its great possibilities to him. A lover of Mozart, he beamed his pleasure as he selected the various compositions and played them at random.

But suddenly his face clouded. He bit off the end of his big cigar and threw it down viciously. In an apoplectic rage he bellowed:

"Fips, you colossal nincompoop, you've done it again! If I ever print an account of this insane contraption in our magazine, most of our advertisers will cancel their contracts—we'll ruin them and they'll ruin us. Why don't you ever think these things through, you . . . you jabbering, jinxed jackass!"

With that he banged my head against something soft on the wall. As I fled out of his office, I noted that he had slammed me against a thick, large leaf-type wall calendar. The date read:

APRIL 1

making HIGH-POWER MADT transistors

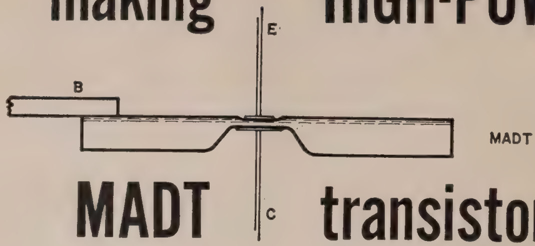
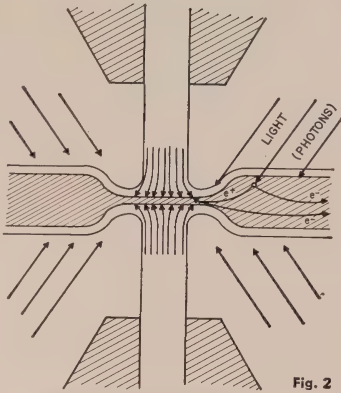


Fig. 1



STANDARD ETCHING TECHNIQUE

Fig. 2

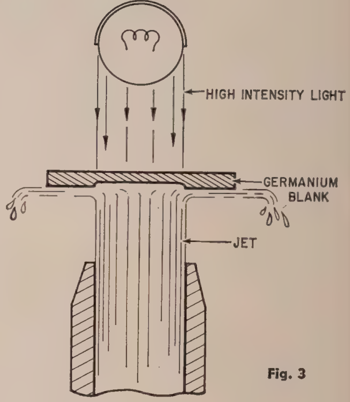


Fig. 3

THE secret behind Philco's high-power, high-frequency, MADT transistors, rated at more than 500-mw dissipation, is *E*tching by *T*ransmitted *L*ight, ETL. Until now, these units (*M*icro *A*lloy *D*iffused-base *T*ransistors) have been limited to low-power applications (75 mw maximum) because of the small size of the transistors' active area. By making this area larger, power ratings of the completed transistors can be increased.

The problem sounds simple, but it isn't. MADT transistors are made by starting off with a blank of germanium base material and electrolytically etching away a small section on each side, leaving only a very thin layer. Collector and emitter electrodes are later plated into these etched-out areas (Fig. 1). The larger the diameter of these pits, the larger the active area of the transistor and the greater its power handling capabilities.

Under existing techniques, etching is an electrochemical jet process. Jets of electrochemical solution are directed against the illuminated surfaces of the germanium blank. This forms tiny pits of precisely controlled diameter and depth (Fig. 2).

Here's how it works. The surface of a germanium wafer is composed of hydrated germanium atoms that are tightly bonded to germanium atoms deeper in the crystal by pairs of electrons. To remove germanium atoms at the surface, holes must be brought in to replace the bonding electrons, permitting the surface atoms to dissolve in the jetstream.

Light (photons) impinging on a germanium atom in the wafer creates hole-ejection pairs. The electrons thus created move off to the external circuit. The holes drift to the surface being etched. Four such holes replace the electrons which bond the hydrated germanium atoms at the surface and the atoms can then be removed.

This etching process produces flat-bottomed etch pits up to 12 mils in diameter. Attempts to make larger pits resulted in uneven base thickness ranging from very thin at the edge of the pit to very thick at the center. This uneven base construction ruins the base blank. This happened because the wafer was illuminated from the sides of the jetstream, the center being poorly illuminated.

Philco's ETL technique emerged from the discovery that, if a germanium wafer is illuminated by high-intensity light *from the side not being etched,* light penetrates the material throughout the region being etched (Fig. 3). This transmitted light generates an even, massive concentration of holes. As a result, the pit etches at a uniform rate and a very flat bottom results—within one wavelength of sodium light. The etched hole can have diameters greater than 100 mils. Transistors made in this manner retain their high-frequency characteristics and gain increased power ratings of 500 mw and higher. END

TV Service CLINIC

conducted by

JACK DARR, SERVICE EDITOR

This is *your* column in the magazine: the service is absolutely free; there is no charge for answering your questions, and your name and address will be kept confidential if you so wish. The main purpose of this is to help everyone working in electronics with their unusual problems; so send in your questions; each one gets an immediate personal answer. Later, the more interesting cases are published in the Clinic columns.

Due to the many peculiarities found in commercial TV circuits, you might find a different answer to a question than the one we give, even though the "conductor" of this column is himself a full-time professional TV technician. We would be interested to hear of such cases, as we feel that the more widespread the knowledge of such peculiarities, the better off we'll all be! So, if you have an unusual service job, or one which is giving you trouble from an obscure cause, send in a question on it; we'll answer it promptly and to the best of our ability. (Incidentally, you'd be surprised to know how many times we get a question concerning something on a given set, and then run into the identical condition in the next day or two! In this way, we get an actual check on the validity of our diagnosis.)

Running the TV trap line

AN item often overlooked as a possible source of TV troubles is the traps. Fig. 1 shows some of these.

Most instructions say to set the traps *first*. This is a good idea; a misaligned trap can make your curves unrecognizable!

Traps get rid of undesired frequencies. These may be from another station, or beats generated within the receiver itself.

For example, in the average TV receiver you'll find the following minimum traps:

Adjacent-channel sound—usually located in input of video if amplifier or in second video if stage. It is set to absorb this frequency to prevent herringbone or tweed patterns on the screen. The accompanying-sound trap in Fig. 1 takes out part of the sound carrier, especially in bandpass video if's and older split-sound receivers. It is not too common in intercarrier TV's with stagger-tuned video if stages, but might be there!

In intercarrier sets, sound and picture carriers are heterodyned in the video detector to provide a 4.5-mc sound if. Since we don't want this beat to go any farther in the picture signal circuits, we put a trap in the video amplifier stage to eliminate it. You'll often find this trap combined with the sound takeoff transformer or coil.

In the input transformer on the tuner (not shown) there is an FM trap, if trap and so on. They trap out signals from nearby FM broadcast stations which might cause picture interference on the low channels or the lower high channels—7, 8. The if traps reduce the amplitude of signals from police radio or two-way communications transmitters which might fall within the bandpass of the 40-mc if sets.

Trap alignment

Aligning traps isn't too difficult. It *can* be done with an rf signal generator, although sweep alignment equipment makes it simpler. Just remember that a trap removes undesired frequencies, and align all traps for *minimum* response!

With sweep alignment gear, set up the video if response curve on the scope. Be sure to use the correct override bias. It differs from set to set, so check it.

Locate the trap frequencies on the response curve with the markers (Fig. 2). In an intercarrier if, the sound carrier must be attenuated. The 41.25-mc trap takes care of this.

Set the marker exactly on 41.25 mc and tune the trap for minimum amplitude at this point. Next, set the marker to the adjacent-channel picture trap, 39.75 mc, and tune this trap for minimum amplitude at that part of the curve. This may be off screen to the left. If so, increase the gain of the marker and sweep generators to get this point up off the base line so you can see it.

Still using the same curve, set the marker to the adjacent-channel sound frequency, 47.25 mc, and tune this trap for minimum signal. Now you can go ahead and finish the if alignment for proper curve shape. Incidentally, for a good quick-check for trap efficiency, pinch the trap with the fingertips while the response curve is displayed on the scope screen. This will detune it enough to make that portion of the curve rise, and tell you whether the trap is on the right frequency.

FM and if traps in the tuner input are easier to adjust with a modulated rf signal. Connect the scope to the video detector or video amplifier, and

(*Continued on page* 64)

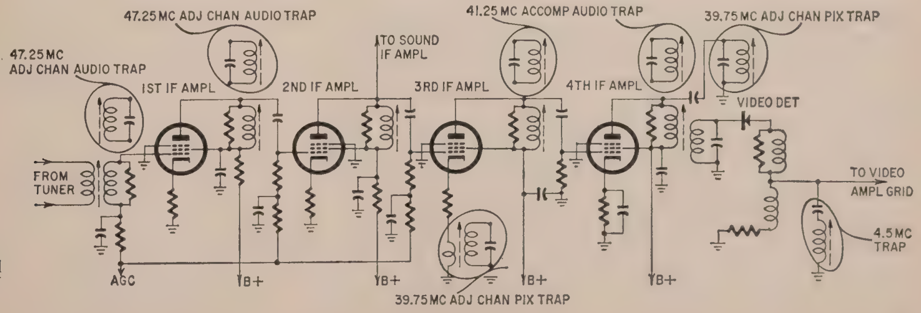

47.25 MC ADJ CHAN AUDIO TRAP
47.25 MC ADJ CHAN AUDIO TRAP
TO SOUND IF AMPL
41.25 MC ACCOMP AUDIO TRAP
39.75 MC ADJ CHAN PIX TRAP
1ST IF AMPL
2ND IF AMPL
3RD IF AMPL
4TH IF AMPL
VIDEO DET
FROM TUNER
TO VIDEO AMPL GRID
4.5 MC TRAP
AGC
B+
B+
B+
B+
39.75 MC ADJ CHAN PIX TRAP

Fig. 1 — Typical traps found in TV receivers.

50-WATT STEREO AMPLIFIER AND CONTROL CENTER

Get the most from your stereo system with this superb unit; power-packed 50 watts (25 w. per channel); complete tone, balance and stereo /mono function controls; five dual-stereo inputs plus separate monophonic mag. phono; mixed-channel center speaker output; luggage-tan vinyl clad steel cover. 31 lbs.

Kit Model AA-100	**$84.95**
Assembled Model AAW-100	**144.95**

GET BIG STEREO SOUND AT LOWEST COST WITH THIS COMPLETE STEREO-PHONO CONSOLE . . . NOW IN ASSEMBLE OR KIT FORM FROM $129.95 UP

Modest only in size and price, this new Heathk Stereo-Phono Console amazes every listener with i room-filling, true-to-life stereo sounds. Proportione to fit any room, it's less than three feet long and on end-table height, yet it houses a complete stereo-phon system with features usually found only in much large consoles. There's *six* speakers . . . two 12″ woofers fo smooth "lows," two 8″ speakers and two 5″ cone-typ tweeters for "mid-range" and "highs". The 4-spee automatic stereo /mono record changer is equippe with an "anti-skate" device and a turn-over diamon and sapphire styli cartridge. On the front panel ar separate, dual bass and treble controls plus a concentric volume control. The handsome cabinet wit solid genuine walnut frame, walnut veneer front pane and matching "wood-grained" sliding top measure just 31¾″ L x 17⅝″ D x 26¾″ H. Whether you bu the ready-to-play or kit form, the cabinet is factor assembled and finished. 70 lbs.

Kit Model GD-31	**$129.9**
Assembled Model GDW-31	**149.9**

COMPLETE 28-WATT AND 50-WATT STEREO CONSOLES

Enjoy incomparable Heathkit stereo with factory wired components in beautiful preassembled, prefinished cabinets . . ready to use! The consoles are available in both 28 and 50 wat models, with money-saving optional kit plans. The 28-wat model (HFS-26) contains the Heathkit AJ-10 stereo AM /FM tuner, SA-2 stereo amplifier, AD-50A stereo record changer an two US-3 12″ coaxial hi-fi speakers. The 50-watt model (HFS-28 contains the Heathkit AJ-30 deluxe stereo AM /FM tuner; AA 100 deluxe stereo amplifier; AD-60B deluxe stereo record changer and two Jensen H-223F coaxial 2-way 12″ hi-fi speakers. Specif walnut or mahogany.

Assembled Model HFS-26 . . . 215 lbs.	**$475.0**
Kit Model HFS-27 . . . 215 lbs.	**370.0**
Assembled Model HFS-28 . . . 264 lbs.	**675.0**
Kit Model HFS-29 . . . 264 lbs.	**550.0**

(Cabinets available separately, write for information)

HEATHKIT by DAYSTROM

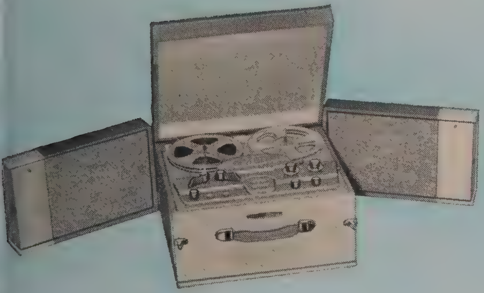
STEREO/MONO PORTABLE PHONOGRAPH

Now you can thrill to magnificent stereo wherever you are, wherever you go! The smartly-styled cabinet with two-tone aqua and white durable vinyl covering comes completely preassembled. In closed carrying position the speaker wing and main cabinet blend into a single handsome unit in dazzling aqua and white vinyl. In use, the detachable speaker-wing top may be spaced at any distance for maximum stereo effect. The completely preassembled automatic changer plays your favorite stereo and mono records at speeds of 16, 33⅓, 45 and 78 rpm, while controls on the amplifier section give you complete command of volume, stereo-balance and tonal quality. 28 lbs.

Kit Model GD-10.. **$69.95**

ok forward to the happy months ahead

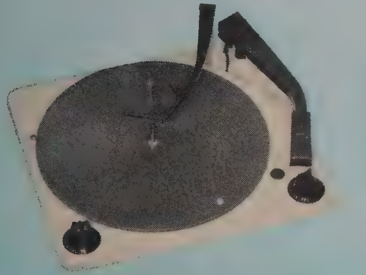
of outdoor living with Heath equipment



PORTABLE 4-TRACK STEREO TAPE RECORDER

Plays and records 4-track stereo tape for endless hours of delight! Can even be used as a hi-fi center to amplify and control tuners, record players, etc. Has "record," "play," "fast-forward" and "rewind"; 2 speeds (3¾ and 7½ IPS); tone balance and level controls; monitoring switch for each channel to let you hear programs as they are recorded; pause button for editing; and two "eye-tube" recording level indicators. Speaker wings are detachable. Cabinet and tape mechanism are preassembled; all amplifiers and speakers included. 49 lbs.

Kit Model AD-40.............. **$179.95**



NEW LOW COST STEREO RECORD CHANGER KIT

Here's fine changer features at a budget price . . . oversize 11″ turntable, "anti-skate" device, jam-proof mechanism and plug-in cartridge head. 4 speeds with automatic shutoff. Assembles easily, quickly with no special tools. Complete with your choice of three different, famous-name, diamond-styli stereo cartridges. 15 lbs.

Model AD-80C, Sonotone 8TA4-SD cartridge	**$37.95**
Model AD-80A, GE VR-227 cartridge	**41.95**
Model AD-80B, Shure M8D cartridge	**42.95**

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ALL 3!

1. HEATHKIT for do-it-yourself hobbyists.

2. HEATHKIT factory-built, ready to use.

3. HEATHKIT learn-by-doing Science Series for youngsters.

REVERBERATION SYSTEM

Add a thrilling new "cathedral" dimension to listening! Reverberation supplies the dimension of spaciousness to sound, as heard in concert halls, etc. where "echoes" enrich and reinforce the original sounds. The GD-61 adds reverberation acoustically, not by electronic mixing, thus it doesn't disrupt your present system and it may be placed anywhere for best listening effect. Can be connected to speaker terminals of hi-fi systems, radios, TV sets, etc. Control lets you add just the right amount of reverberation. The GD-61 consists of Hammond type IV reverberation unit, amplifier with power supply and 8″ speaker. Preassembled birch cabinets in mahogany or walnut finishes. Measures 11½″ H x 23″ W x 11¾″ D. 30 lbs.

Kit Model GD-61M (mahogany) or
GD-61W (walnut) each.............................. **$69.95**

IEATH COMPANY / Benton Harbor, Michigan

TWO AND SIX METER TRANSCEIVERS

The "ham on the go" will find the new Heathkit "Shawnee" 6-meter and "Pawnee" 2-meter transceiver kits irresistible! Both of the handsome units offer complete AM and CW facilities with: single knob tuning . . . tracked VFO and exciter stages; 10 watt output; built-in low pass filter; three-way power supply built-in for 117 VAC, 6 VDC or 12 VDC with separate DC and AC plugs and cables included; dual-purpose modulator . . . 10 watts for high level plate modulation or 15 watts for PA operation; double conversion receiver . . . crystal controlled first oscillator; tuning meter . . . auto-switched for received signal strength or relative power output; VFO or crystals . . . front panel switch of VFO or four crystals for novice, CAP, MARS or net operation; "spotting" switch; complete shielding of power supply, final and receiver front end; ceramic microphone . . . push-to-talk with coiled cord. And many more outstanding features . . . write for information. 34 lbs.

Kit Models HW-10 (6 meter) and **HW-20** (2 meter) each................................**$199.95**

look forward to the happy months ahead
# of outdoor living with Heath equipmen

6-TRANSISTOR PORTABLE RADIOS

These award-winning, smartly-styled portables are ready to go anywhere! Both feature vernier tuning; 6-transistor circuit; 4″ x 6″ speaker for big set tone; prealigned transformers. 6 flashlight cells furnish power. (less batteries).

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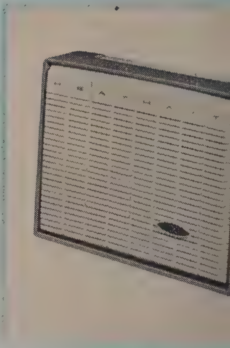

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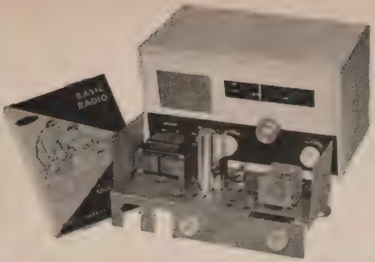

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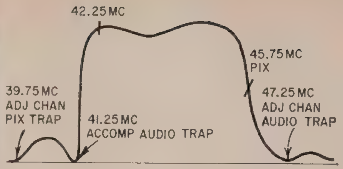


Fig. 2—Typical response curve of 40-mc if strip, showing the location of different trap notches.

(*Continued from page* 59)

set the signal generator to produce a signal at the right frequency. This will give you a 400-cycle wave on the scope. If you don't want to bother with the scope, it also gives you a series of horizontal black bars on the CRT!

Tune the trap for the lowest amplitude of the 400-cycle waveform, or the faintest bars on the screen. Incidentally, if a police transmitter in the neighborhood is causing interference, find out its exact frequency and set the FM and if traps for minimum interference at that frequency.

The 4.5-mc trap in the video detector or amplifier output is also easier to set in this way. Feed the signal into the video detector or last video if stage, and tune the 4.5-mc trap for minimum ac (AM signal) at the picture tube.

You may find other specialized traps in some sets, but they are identified in the service data. Align them according to instructions. Frankly, most trap misalignment is due to tinkering. The trap adjustments are often in the same can with the video if's, and they get turned by mistake while fiddling with the if alignment!

Nonlinearity in scope

I just built a kit oscilloscope. It works fine, but there is a slight nonlinearity in the horizontal sweep. Is this due to the adjustment of the compensating capacitors in the probe?—B. C., Houston, Tex.

Ordinarily, no. These capacitors affect the probe's frequency response, but won't affect the horizontal linearity.

Check all coupling capacitors, resistors and especially tubes in the horizontal oscillators and sweep amplifiers. It takes only a very small leakage through a coupling capacitor to affect linearity, especially at high frequencies.

Retrace lines

I added a dc restorer to my Philco TV. Now I have very pronounced vertical retrace lines.—R. F. S., Cambria, Va.

Reverse the diode. This is the most likely cause of vertical retrace lines in a dc restorer circuit.

Horizontal shrinkage

We are working on an RCA 21T176 TV which has a bad case of horizontal shrinkage. We've replaced the cathode and screen resistors in the horizontal output tube circuit, also the horizontal oscillator transformer and all parts in that circuit, but to no avail.

After the picture shrinks, there is no horizontal drive and the plate of the output tube gets red. If we turn the set off and then on again, the picture fills out again. If we increase the cathode resistor on the output tube by about 150 ohms, the raster will come back on. We can also get it back by increasing the screen voltage.—T. K., Howard Beach, N. Y.

The root of this problem lies in that horizontal drive signal. You can bring back the raster by increasing the dc bias on the horizontal output tube or the screen voltage. This indicates trouble in the grid circuit of that stage.

There may be dc leakage through the coupling capacitor. This would give the same effect as reducing the dc bias on the output stage. Check this by replacement. Also, and a common cause of trouble in this set, is leakage in the horizontal-drive trimmer capacitor. Take it apart and examine the mica carefully for signs of puncturing, moisture. Better still, replace it.

It would also be a good idea to check the grid resistor on the 6CD6, the 1-megohm unit. If it is changing because of heat, it would also upset the bias.

Buzz during warmup

An Admiral 21E3Z emits a strong buzz during the first few minutes, as if the filter capacitors were bad. Yet, they're good. This happens after the set has been off for 24 hours.—E. H., Palo Alto, Calif.

This sounds like agc warmup buzz. Check the sound output with a scope and observe the *shape* of the buzz waveform! If it's a sine wave (Fig. 3-a), it's caused by slow-forming filters. If it's a spike (Fig. 3-b), it's caused by excessive voltages in the vertical sweep circuit, probably the output. If it's a complete flat-topped blanking pulse (Fig. 3-c), it is probably caused by the agc.

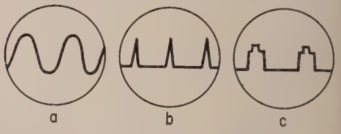


Fig. 3—Waveforms of audio output can indicate cause of buzz: a—sine wave; slow-forming filter. b—spikes; excessive voltage in vertical sweep circuit. c—blanking pulse; agc buzz.

Pix-tube conversion

Can I convert a Sparton 26SS170 from its present 17-inch picture tube to a 21-inch aluminized tube? Can you tell me what yoke and flyback I would have to use, and what other changes would have to be made?—E. R. McC., Lancaster, Calif.

Some TV sets are pretty hard to convert, but this model does not look as if it would give you too much trouble. The high-voltage power supply and so forth should do very well, especially with those paralleled 6BQ6's.

Your best bet for this would be to select a 21-inch tube that would work with as many of the original parts as possible. For example, your present 17-

inch tube has a 70° deflection angle. If you choose a 21EP4-B, which is also aluminized, you would have the same deflection angle, and the high voltage required is only 16,000 volts. If your high-voltage and sweep circuits are in perfect shape now, it looks as if you should be able to sweep this tube with plenty of brightness.

If you cannot get enough width, try some of the tricks for increasing it: add a small (20- to 40-μμf) capacitor across the damper tube (with at least a 4,000-volt rating); increase horizontal drive to maximum; change the screen voltage of the 6BQ6's slightly. Watch the plate current of the 6BQ6's closely. After all adjustments have been completed, check to see that the maximum plate current of 100 ma (per tube) is not exceeded. You might get that last bit of width, if needed, by changing the 6BQ6's to the slightly hotter 6DQ6's.

Vertical deflection should work out pretty well with existing parts. Be sure to check the vertical output cathode bypass capacitor and replace if necessary.

A few other tube types might work, depending upon availability, price, etc.: 21FP4-C, 21JP4-A and so on. To avoid drastic changes, I would definitely recommend using a 70° tube for this conversion, rather than any of the 90° types.

Weak video

An Admiral 16B1 has normal sound, but the picture is just a shadow. Also there is very little sync, and very little gain in the video output stage. The plate voltage of the video output tube is low, all others correct.—H. S., Albion, Ind.

There is one very likely source of trouble—either the series or shunt peaking choke in the video amplifier output plate circuit (Fig. 4).

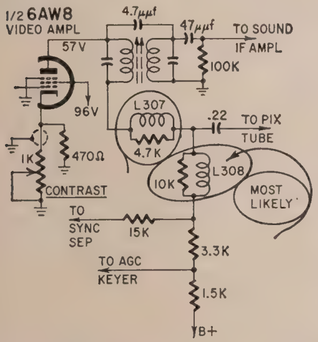
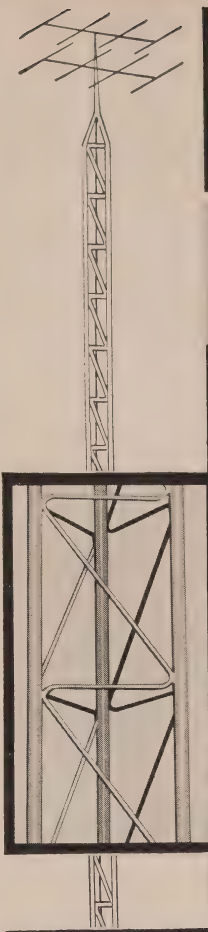


Fig. 4—Video amplifier stage in Admiral 16B1. Open peaking chokes, especially L308, could cause loss of most of the video signal and affect the sync.

These consist of rf chokes wound on resistors. If the choke opens, the dc plate voltage drops and the video falls off because of the change in the peaking. Check all of these, and the sound takeoff transformer too, for proper continuity—they should measure only a very few ohms. END



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Inventors of Radio

DAVID EDWARD HUGHES

By DEXTER S. BARTLETT

DAVID EDWARD HUGHES was born May 16, 1831, in London, England, but the family emigrated to America when he was about 7 years old. In 1850, he became professor of music at the College of Bardstown, Kentucky, and, soon after, of natural philosophy.

Hughes' first research was with wire telegraph apparatus, for which he invented the polarized relay for more reliable action. Also, as early as 1855 he patented a type-printing telegraph, which could handle 30 words per minute. The forerunner of the modern teletype, it had means for synchronizing the transmitter and printer, with provision for correcting sync with each word sent, plus many other features used in today's equipment. By 1856, it was in use between New York and Boston and, by 1862, in a limited way, throughout Europe. However, in those days labor was cheaper than automation, so the Morse operators stayed at their keys.

Next, in 1878, he turned his research to the telephone and made a major breakthrough with the first carbon microphone. Previously, Wheatstone, as far back as 1827, and Reis, in 1861, had tried, producing instruments that would transmit only tones or scratches. The Hughes microphone consisted of a bar of carbon on two supports of the same material. The imperfect contacts were affected by sound waves and would therefore transmit sound signals. He did not patent his microphone, believing it to be a discovery rather than an invention. Among those who improved Hughes' invention was Edison, who used carbon granules for his imperfect contacts, thus producing our modern telephone transmitter.

In 1879, while working on his microphone, Hughes noticed a noise in his phones when a current was interrupted in another coil a few feet away. In a letter to Sir William Crookes, he wrote, "Further researches proved that an interrupted current in any coil gave out such intense extra currents that the whole atmosphere, even several rooms distant, would have a momentary charge which was received by my telephones, even through obstacles such as walls."

Hughes used his imperfect-contact microphone as a detector. He discovered also that a loose contact between metals was equally sensitive, but that the metals would cohere after the passage of a wave, making the device useless. Thus Hughes discovered—and discarded—the coherer 10 years before its invention by Branley.

He staged a demonstration before members of the Royal Society, in which he transmitted and received signals over a distance of 500 feet. One of the secretaries of the society, Professor Stokes, insisted that all the effects could be explained by induction, and argued his point with such vigor as to convince the delegation. Discouraged by the attitude of Professor Stokes, Hughes refrained from publishing the results of his experiments. However, he continued them for some years, ceasing apparently on the publication of the work of Hertz, which explained to him and the world the true nature of the waves whose existence Professor Stokes had denied.

After his discouragement and the subsequent triumph of Hertz, Hughes maintained a complete silence on his early experiments, relating them only after considerable persuasion to the historian of telegraphy, J. J. Fahie, in a letter dated April 29, 1899.

In his later life, he invented the induction balance (commonly called the Hughes balance), now used in metal locators and mine detectors. He also revised and organized his many papers on electricity and magnetism. Dying in 1900 in England, where he had spent the latter part of his life, he left a considerable fortune, which, according to his will, was divided among such projects as the establishment of scholarships and prizes in physical science, as well as donations to four London hospitals.

It has been said of Hughes' experiments in radio that they "were virtually a discovery of Hertzian waves before Hertz, of the coherer before Branley and of wireless telegraphy before Marconi and others." END

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USING PICTURE-TUBE BRIGHTENERS

Watch which brightener you put on those new low-voltage picture tubes—the wrong one can damage the tube permanently

By RICHARD GOLDSTEIN *

EVERYONE actively working at TV servicing knows the value of a tube brightener. These devices, which greatly prolong the useful life of picture tubes, have proved themselves big money savers for the set owner and effective good-will builders for the service dealer who installs them.

Since brighteners are low-cost items easy to install, they tend to be taken for granted. However, recent advances in picture-tube construction, coupled with the wide variety of heater ratings now in use, complicate the situation (see Table I).

In the past there was little danger in installing a brightener that was wrong for the picture tube or circuit. It just wouldn't work, and substituting the right unit provided the cure. Today, however, with many series-string low heater-voltage tubes in the field, the wrong brightener can pop the heater or produce a heater-to-cathode short, terminating instead of increasing useful picture-tube life. In view of these changes, a review of tube brightening techniques is important to every technician.

How a brightener works

The earliest attempts to restore brightness to dim picture tubes showed that the most practical method (US Patent No. 2,757,316) is to apply a carefully controlled increase in power to the tube heater and to maintain this increased power during normal operation. Since the cathode structure used in cathode-ray tubes is very special and differs greatly from that of ordinary receiving tubes, this technique extended useful tube life remarkably.

When tube brighteners were first introduced, the problem of boosting heater power was relatively simple. Only one type of tube base was in widespread use, and heater voltage and current were the same for all picture tubes. A simple stepup transformer fitted with an adapter plug and socket could be inserted in the heater wiring to the tube to provide the desired power increase.

This simple situation did not last very long. Manufacturers began to produce TV sets with series-string heater arrangements. These new set designs required new transformer designs for tube brighteners. In addition, it was found that by using isolation transformers instead of the autoformer type, normal operation can be restored to a tube which has developed a heater-to-cathode short. (This is possible because of the separation of the heater from the rest of the set's circuitry.) Thus there is a need for isolation transformers for both parallel and series wired sets. These transformers should provide not only increased power but also normal heater power for tubes that do not require brightening but have heater-to-cathode shorts.

Wrong brightener dangers

Today three picture-tube basings are in common use (duo-decal, button and small shell), two heater wiring arrangements (parallel and series) and seven heater ratings. To meet the needs of the service technician a variety of brighteners is available to accommodate these combinations.

Technological advances have resulted in many new picture-tube types. Manufacturers have introduced tubes with controlled heater warmup characteristics for series-string operation. Many of them have heater voltages and current ratings different from the older types. Furthermore, the increase in deflection angle to 110° required a smaller-neck tube so several new basing arrangements were introduced.

Dim tubes can be brightened by increasing heater power. The question is, "How much?" Insufficient increase in heater power results in insufficient brightening, but too much boosting results in a high rate of heater burnouts and too rapid depletion of the cathode coating, hence a much shorter extension of useful tube life. Research indicates an increase in heater power of approximately 50% best avoids these dangers and extends useful tube life to the maximum. Since cathode-ray tubes are subjected to a considerably greater than normal heater power during the manufacturing process known as "forming the cathode," designers have provided ample ruggedness in these heaters. Thus the moderate power boost required for optimum brightener performance doesn't cause any observable increase in burnouts.

Although any brightener must be chosen carefully, extra caution is demanded when using a boosting transformer on series-string heaters. As has been previously indicated, a number of new tubes designed for series-string applications use considerably less power than the older types. Because of the smaller wire sizes in the heater and the closer spacings between heater and cathode, these tubes are more susceptible to failure from excessive heater power. Brighteners designed for the standard 6.3-volt 600-ma heater in series-string use will greatly overpower some of these new tube heaters and underpower others.

Investigation of the problems resulting from the use of the wrong brightener requires careful consideration of the nonlinear behavior of the picture-tube heater. Like any tungsten filament, the heater has considerably more resistance when hot than when cold. While this tends to protect against excessive power under conditions of higher than normal voltage, the situation is *just the opposite* in series-string applications, Here the brightener operates on a nearly constant current, rather than constant voltage as in parallel operation. The current applied to the tube heater is therefore, the *independent* parameter and the voltage adjusts itself according to the new resistance value.

Because of the tube heater's nonlinearity, a given percentage increase in current will cause much greater increase in *power* than the same percentage increase in voltage. This is shown in Table II, which clearly illustrates why the picture-tube brightener must be considered a booster of power rather than a booster of voltage or current. Note that a 50% increase in rated voltage doubles the power, but a 50% increase in current triples it. The importance of considering the boost in *power*, rathen than voltage or current applied to the picture tube heater, can be realized by comparison with a linear resistance. For a 100% increase in current in a linear resistance the power is increased four times. This same increase in a picture-tube heater current results in a power increase of almost seven times.

---

*Perma-Power, Chicago, Ill.

How many brighteners

Fortunately there are a great many similarities among picture tubes as well as differences, so that it is possible to meet the demands of the vast majority of picture tubes in general use today with a relatively small number of brighteners.

Naturally, the lowest-cost brighteners are designed for only a single purpose. More costly units have been developed to combine various functions, avoiding a vast multiplicity of products to burden the dealer's inventory. The types on the market today can be classified in four major categories:

- single-purpose autoformer
- two-way autoformer
- universal
- restorer

The single-purpose autoformer provides maximum economy. These units are available for either parallel- or series-wired heaters in the most popular tube bases and heater ratings.

The two-way autoformer, also available in the most popular tube bases and heater ratings, can be set for either parallel or series operation. These units permit the dealer to reduce his inventory while satisfying the majority of brightener requirements.

The universal units use isolation transformers to relieve heater-to-cathode shorts. These versatile units can be switched to provide either parallel or series operation, and they can deliver normal as well as boosted power to the tube heater.

The restorer is similar to the universal except that it provides a higher power boost for correction of open-cathode leads. In addition, they can correct for open or shorted control grids.

Selecting the proper unit

It is, of course, possible to select the proper brightener by analyzing set construction and relating it to brightener types. The information required for this selection includes the heater wiring circuit used in the TV set (parallel or series) and the picture-tube base type and heater rating.

While the two heater wiring circuits, three bases and seven heater power ratings would indicate 42 different combinations, these are not all in common use. A careful study of TV sets reveals only 16 of the combinations in present-day TV sets. However, other combinations will come into use as manufacturers improve set circuitry or use new circuits.

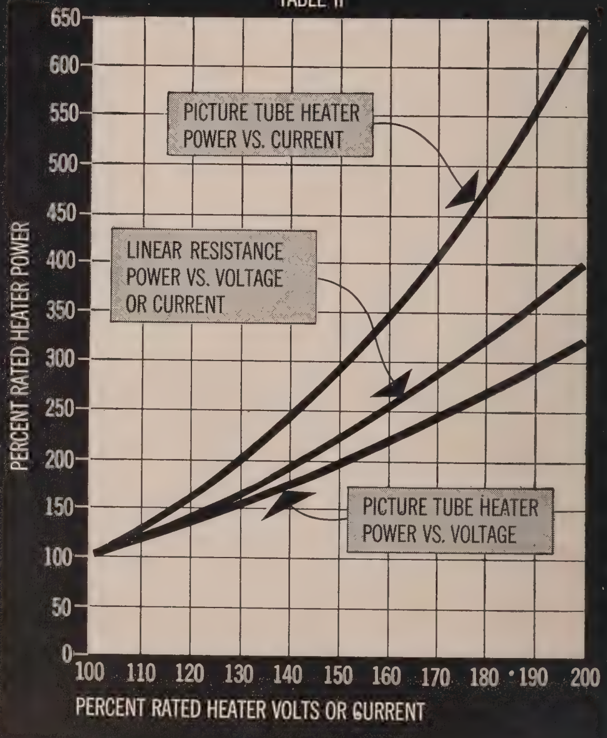
When the exact circuit and picture tube information has been obtained, a brightener can be selected to correspond to the data. There are some short cuts in the selection process. Most manufacturers have brighteners that can accommodate either parallel- or series-heater circuits for the most-used TV

TABLE I

PICTURE-TUBE TYPES AND APPLICATIONS

BASE	HEATER VOLTS	HEATER MA	PROBABLE HEATER WIRING CIRCUIT
DUODECAL (CONVENTIONAL) 21AMP4, 21EP4, 21AP4, 17LP4, ETC.	4.7	300	SERIES
	6.3	300	SERIES
		450	SERIES
		600	SERIES OR PARALLEL
	8.4	450	SERIES
BUTTON (110° RIGID PIN) 21DAP4, 21EQP4, 24AHP4, ETC.	2.34	600	SERIES
	2.68	450	SERIES
	6.3	300	SERIES
		450	SERIES
		600	SERIES OR PARALLEL
	8.4	450	SERIES
SMALL SHELL (110° SPECIAL BASE) 21CQP4, 21CSP4, 24AMP4	6.3	450	SERIES
		600	SERIES OR PARALLEL

TABLE II



tube bases and ratings (two-way brighteners). Another short cut is the use of selector guides. For example, the Perma-Power Selector Guide lists every picture tube in general use and gives its base and heater rating as well as indicating which model or models of Perma-Power brighteners can properly and effectively be used to provide maximum operating efficiency and best prolong the life of the tube.

Using brighteners

Now that we've seen where to use what brightener, let's see how a service technician can use tube brighteners to give his business and reputation a boost.

Joe's Service Co. gets a call and Joe finds a weak picture tube. He suggests a new one. The customer doesn't have enough money to pay for a new picture tube, so she pays Joe for his call and tells him, "I'll call you back in about a week." A week later she does call—John's Rapid TV Repair, and not Joe. Seems that John has a special on picture tubes this month at a lower price than Joe quoted.

But try this approach. When Joe sees the weak picture tube, he hooks on a brightener. When it brings the picture up to normal, he tells the customer, "Yes, ma'm, your picture tube is weak. However, I've installed a brightener that will keep it working a while longer, up to about 6 months. Now, I'll have to charge you $4 for the brightener plus my usual service charge, but when your picture tube does go out again I'll allow you the $4 you're paying for the brightener toward a new tube."

Customer reaction is good all around. Obviously you're not trying to take her for a ride. Her picture tube is bad, but she'll have to lay out only $8 to $10 now and she may be able to put off getting the tube for a whole half a year. Best of all, when she does have to get the tube, she gets back the $4 she spent to keep the set working. And that $4 refund is what insures your getting the picture-tube replacement job when it does come up. END

"It's for those hard-to-reach places."

Get ALL Basic Color-TV Test Patterns From This ONE Low-Cost Generator

COLOR BAR/DOT/CROSSHATCH GENERATOR
WR-64A
Color Television
PATTERN

RCA WR-64A

COLOR-BAR/DOT/CROSSHATCH GENERATOR

Here is the low-cost, lightweight, high-quality instrument that gives you all essential Color-TV test patterns: Color-bar signals for checking, adjusting and trouble-shooting Color-TV circuits; dot and crosshatch pattern signals for adjusting convergence in color receivers and for adjusting linearity and overscan in *either color or black-and-white receivers.* Designed for in-the-home or shop servicing. ONLY $189.50*

*User Price (Optional)

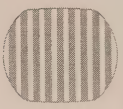
SIMPLICITY: Only three operating controls! Provides RF output...connects directly to antenna terminal of receiver. No external sync leads needed.

STABILITY: Crystal controlled signals assure accuracy and dependability. Patterns are rock-steady, free from "jitter" and "crawl".

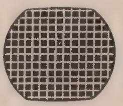
PORTABILITY: Weighs only 13 pounds. The ideal test instrument for proper in-the-home color-TV adjustment and servicing.

FLEXIBILITY: Extra wide range on chroma control..."standby" position on function switch ...fixed number of dots and bars..."on-off" control on sound-carrier.

GENERATES:



Color-Bar Pattern...Ten bars of color including R-Y, B-Y, G-Y, I and Q signals spaced at 30° phase intervals for checking phase and matrixing, and for automatic-frequency and phase alignment.



Crosshatch Pattern... A crosshatch of thin sharp lines for adjusting vertical and horizontal linearity, raster size, and overscan. **Dot Pattern** (not illustrated) permits accurate color convergence.

GET ALL THE FACTS ON THE NEW RCA WR-64A

RCA Electron Tube Division Dept. RE
Commercial Engineering
Harrison, N. J.

Please send me your folder (1Q1017) on the new RCA WR-64A Color-Bar/Dot/Crosshatch Generator.

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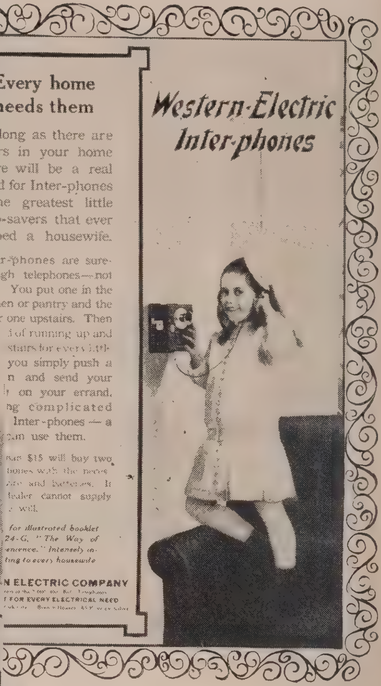
RADIO CORPORATION OF AMERICA

TWO INTERPHONES

1913 ☛

(Right) This advertisement appeared in 1913. (Below) A highly practical use for the Interphone.



Every home needs them

As long as there are stairs in your home there will be a real need for Inter-phones —the greatest little step-savers that ever helped a housewife.

Inter-phones are sure-enough telephones—not toys. You put one in the kitchen or pantry and the other one upstairs. Then
d of running up and
stairs for every little
you simply push a
n and send your
r on your errand.
ng complicated
Inter-phones — a
can use them.

ne $15 will buy two
hones with the neces
ire and batteries. If
lealer cannot supply
e will.

for illustrated booklet
24-G, "The Way of
enience." Intensely in-
ting to every housewife

N ELECTRIC COMPANY
T FOR EVERY ELECTRICAL NEED

Western-Electric Inter-phones

☚ 1961

THE development of a single device over half a century or so may show more dramatically than anything else how much we have advanced within a period we can remember.

Many years ago the telephone company introduced a new service, a home intercommunicator, or Inter-phone, which made it possible for a subscriber to talk from one part of the house to another or to the garage or barn (so said the advertising). The original instrument looked like the one in the top photograph. Apparently Western Electric considered it quite a triumph to produce a home intercommunicator that "even a child can use" even though the child had to climb on a sofa, and showed the situation in its advertising.

The Inter-phone, introduced in 1912, has never been a dominant factor in home or office. It did establish itself over the years in a small minority of homes and an even smaller number of business establishments. The name was well known and, when intercoms began to become popular in the late '30's, all intercommunicators were called interphones for a time.

Recently Western Electric has come out with another intercom—still called the Interphone—but without the hyphen —for use with the latest home phones. (It will still be installed and serviced by the phone company.) Instead of climbing on a chair, the child or adult makes a call by picking up the phone, turning a button and calling anyone in any room with an extension phone. The callee hears the voice from a loudspeaker and answers from whatever part of the room he may be in. A microphone in the base of the extension phone picks up the message and sends it back over the house lines to the caller in any other part of the house that has a phone extension.

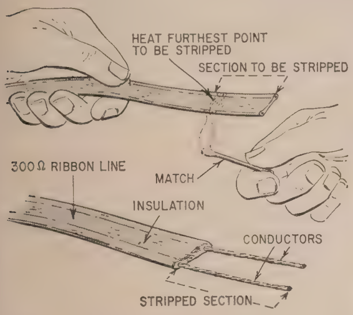
The signals are amplified from microphone level to loudspeaker volume by a five-transistor control unit. The microphones are special jobs installed in the base of the telephone, and the speakers are small units in rectangular plastic cases finished to match the phone.

A "line" and a "hold" button on the home telephone switch the intercom unit into circuit and provide a "hold" position so the caller is excluded from the conversation while the person called seeks information from other members of the family. The "hold" button also makes it easy to transfer an outside call from one telephone to another. A door-answering switch connects the microphone–speaker outside the door when answering the doorbell, excluding all house speakers. (Normally an Interphone call is heard on all the house units, as the most effective means of paging the person desired.)

Intercommunicators are now common in offices. The convenience of the newer Interphone may increase their popularity in the home. Besides the Interphone, there are a number of wired and wireless intercommunicators well adapted to home use. END

Stripping Ribbon Lead

THE service technician generally uses cutting pliers to strip the insulation from multiconductor plastic-covered wires such as 300-ohm twin conductor (stranded leads) antenna lead-in. This procedure is cumbersome and often damages or breaks some of the fine conductor strands. Antenna ribbon lead-in wire is usually stripped by cutting the polyethylene insulation between the two conductors with cutting pliers, shears or knife. The insulation is then cut, stripped and cleaned from each conductor with the cutting tool. When using these cutting tools the technician must use extreme care not to break or nick the fine wire strands. Even for the experienced wire stripper this practice is cumbersome and tedious and often results in breaking or damaging the conductor strands. Also, it is not easy to obtain a good lead dress. For the less experienced craftsman, this method is difficult and results in waste of wire and effort.



A much simpler and cleaner stripping method (without the use of cutting tools) is to apply a small amount of heat to the polyethylene insulation with a match, soldering iron or other suitable heat-producing tool (see drawing). Apply the heat at the farthest point along the insulation to be stripped. When the heat has softened the insulation, quickly pull or slide it off the wires with a small piece of cloth or pliers. This leaves the conductors clean and dressed ready for use. This method takes only a few seconds and is a handy aid to the television antenna installer on location.—*H. Linton, K2OHT*

◆

ENTERTAINING THE CAB DRIVER

A taxicab radio control station in Buffalo was not entertained by hearing local broadcast stations on the frequency it uses for dispatching cabs. A search led to a small personal clock-radio which was radiating a strong signal over the neighborhood. Replacing the set's output tube took the music and news off the cabs' frequency.—*Kilocycling With FCC*

BREAKTHROUGH IN KIT DESIGN!

LK-72 72-Watt stereo complete amplifier kit (left), $149.95. LT-10 Wide-Band FM Tuner kit $89.95.*

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H. H. Scott assures you the performance of factory-built units with these innovations:

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2. Every wire and cable is already cut to exact length and pre-stripped. This saves you time and assures professional performance because exact lead length is automatic.
3. To take the guesswork out of assembly, electronic parts are mounted on special cards in the order in which they are used. No loose bags of parts to confuse you.
4. Full color diagrams in easy-to-follow instruction book simplify assembly and reduce errors because you match the part to the color diagram.

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". . . I would run out of superlatives if I tried to adequately state how I feel about this tuner . . ." — Samuel R. Harover, Jacksonville, Ark.

". . . without a doubt the easiest kit I have ever built (out of 11) . . ." — B. P. Loman, Jr., Rochester, N. Y.

". . . finest kit I have ever built. And one of the finest tuners I have heard, kit or otherwise." — A. J. Zilker, Houston, Texas.

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TRANSISTORIZED SQUELCH FOR CITIZENS BAND

Two outboard (or inboard) subminiature units that will take the noise out of your Citizens radio hookup

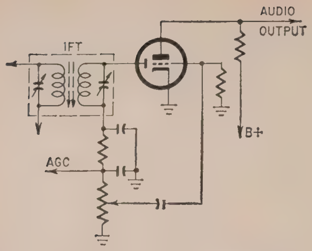

AUDIO OUTPUT
IFT
B+
AGC

Fig. 1—Standard detector–audio stage.

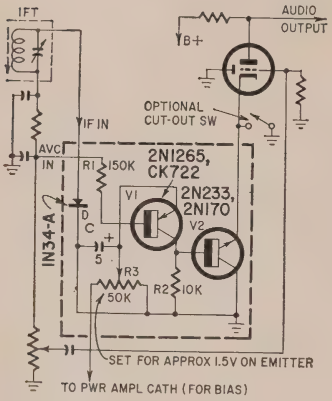
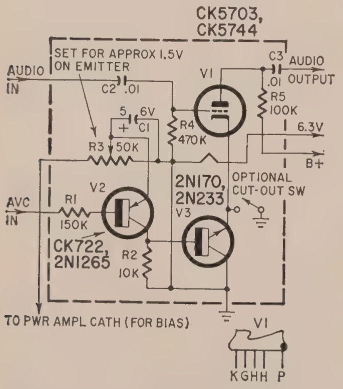

IFT
AUDIO OUTPUT
B+
OPTIONAL CUT-OUT SW
IF IN
AVC IN
R1 150K
2N1265, CK722
V1
2N233, 2N170
V2
1N34-A
D
C
5
R3 50K
R2 10K
SET FOR APPROX 1.5V ON EMITTER
TO PWR AMPL CATH (FOR BIAS)

Fig. 2—The simpler squelch circuit.

R1—150,000 ohms, ¼ watt
R2—10,000 ohms, ¼ watt
R3—pot, 50,000 ohms, miniature
C—5 μf, 6 volts, electrolytic, miniature
D—1N34-A
V1—2N1265, CK722
V2—2N233, 2N170
Circuit board—printed circuit or perforated phenolic
Miscellaneous hardware


CK5703, CK5744
SET FOR APPROX 1.5V ON EMITTER
AUDIO IN
C2 .01
V1
C3 .01
AUDIO OUTPUT
R5 100K
5, 6V C1
R4 470K
6.3V
R3 50K
B+
2N170, 2N233
OPTIONAL CUT-OUT SW
V3
V2
AVC IN
R1 150K
CK722, 2N1265
R2 10K
TO PWR AMPL CATH (FOR BIAS)
V1
KGHH P

R1—150,000 ohms, ¼ watt
R2—10,000 ohms, ¼ watt
R3—pot, 50,000 ohms, miniature
R4—470,000 ohms, ¼ watt
R5—100,000 ohms, ¼ watt
C1—5 μf, 6 volts, electrolytic, miniature
C2, 3—.01 μf, ceramic, 15 volts or higher
V1—CK5703, CK5744
V2—2N1265, CK722
V3—2N233, 2N170
Socket, subminiature (1)
Circuit board—printed circuit or perforated phenolic
Miscellaneous hardware

Fig. 3—This squelch need be inserted only between audio stages.

By TOM JASKI

IF YOU are planning to use a converter to add 27-mc Citizens-band coverage to a superheterodyne table or car radio, you will probably find the noise on the band disturbing, if not outright obnoxious. The only way to remove the noise is with some form of squelch or noise limiter, which will function only when no carrier signal is being received. Here are two little transistorized squelch circuits that can put you in business.

Fig. 1 shows a typical superhet second detector and avc circuit. We cannot include the squelch in the audio portion of the combination tube since it would bias the detector and avc action would be blocked. Fig. 2 shows the modification that makes the squelch work. The cathode of the audio tube has been freed by including a 1N34 diode as the detector. Now the squelch circuit is connected in series with the cathode and the rest of the circuit connected as shown.

Fig. 3 shows an alternate form, in which no change of the detector is required, only a break between the audio from the second detector and the power output tube. The subminiature tube fits into a special clamp (Fig. 4.). If your set has separate detector and audio tubes, use the circuit of Fig. 2, without the diode, to set up the same circuit as in Fig. 3, but using the audio tube in the set.

Here's how it works. The n-p-n diode (emitter to collector of V2) in the cathode circuit of the audio tube will appear as a very high resistance, placing a high bias on the tube and cutting it off. When a positive bias is applied to V2's base, it will conduct and present a very low resistance to the cathode circuit. But the avc voltage, which is generated whenever the set is receiving a carrier, is negative. We invert this negative avc to a positive signal with the p-n-p transistor V1. This transistor is powered from the cathode bias on the output tube, which is well filtered and bypassed. When the avc voltage rises, it puts a positive bias on V2's base and makes the transistor conduct, allowing the audio tube to amplify.

If you want a cutout switch, use an spst switch to bypass the transistor in the cathode circuit.

The photos show the two circuit boards. Both are small enough to fit into most receivers, even compact auto radios. R3 sets the cutoff point by determining V1's emitter voltage. Once set it need not be adjusted again for this is a gate kind of an action and can be set for very great sensitivity. Only a fraction of a volt of avc will open the gate. Yet short noise pulses do not open it since they generate no avc.

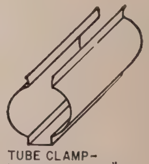

TUBE CLAMP—
MAKE FROM .008"
COPPER OR BRASS

Fig. 4—Special clamp for tube, made of .008-inch sheet brass or copper.

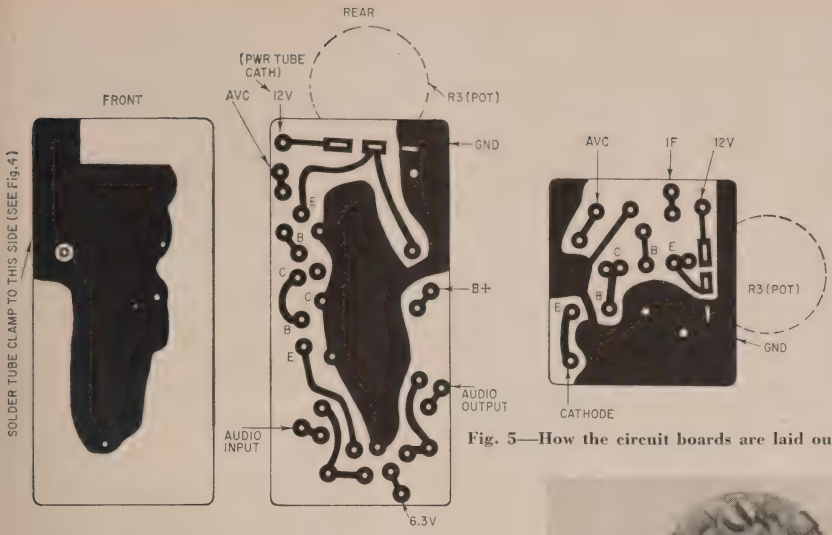
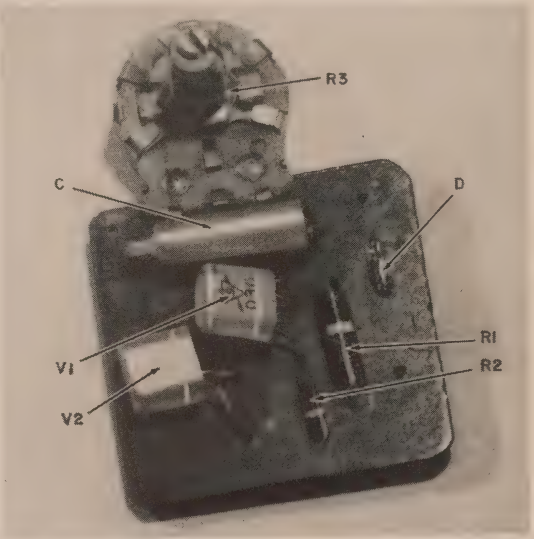

REAR
(PWR TUBE CATH)
AVC
12V
R3 (POT)
FRONT
SOLDER TUBE CLAMP TO THIS SIDE (SEE Fig.4)
GND
E
B
C
C
B
E
B+
AUDIO OUTPUT
AUDIO INPUT
6.3V
AVC
1F
12V
C
B
E
B
E
R3 (POT)
GND
CATHODE

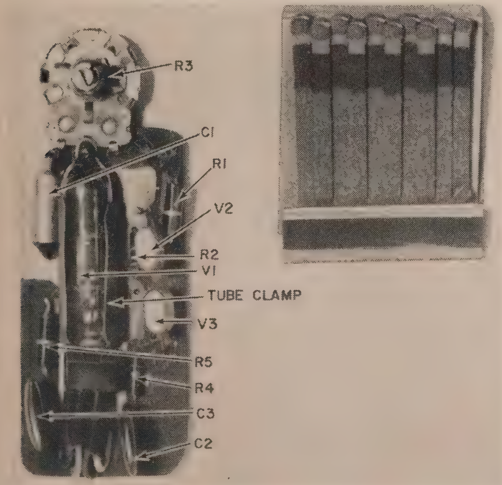
Fig. 5—How the circuit boards are laid out.

Fig. 5 shows the layouts of the circuit boards. You need not use circuit boards at all, but they are a convenience. Both are so light they can be supported by the connecting wires if you use No. 20 solid hookup wire. If your audio connections (in Fig. 3) get fairly long, use shielded wire for them, with the braid grounded on one end only. Caution! If you are working inside an auto radio, which is usually crowded, be sure your braid-covered wire does not short existing connections.

This has been a very satisfactory approach to the noise problem, and it is easy to install. But, if your set is too compact for it, mount the entire assembly on a small plug just outside the cabinet. If you are using the circuit which includes the subminiature tube, your tube will be pretty well shielded by the tube clamp anyway. Pleasant listening! END


R3
C
D
V1
R1
R2
V2

Two-transistor squelch unit.


R3
C1
R1
V2
R2
V1
TUBE CLAMP
V3
R5
R4
C3
C2

Lower left—Special tube has 200-ma 6-volt filament, requires 30-ohm resistor for 12-volt operation.

Lower right—Backs of completed units.

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B. TV & General Electronics (V-7)	2 years of High School including Algebra, Physics or Science	Day Evening	1½ years 4½ years
C. Radio & TV Servicing (V-3)	2 years of High School including Algebra, Physics or Science	Day Evening	9 months 2¼ years
D. Transistors	V-3 or equivalent	Eve. only	3 months
E. Electronic Drafting	2 years of High School including Algebra, Physics or Science	Eve. only	Basic: 1 Year Advanced: 2 Years
F. Color TV	V-3 or equivalent	Eve. only	3 months
G. Audio-Hi Fidelity	V-3 or equivalent	Eve. only	3 months
H. Video Tape	V-3 or equivalent	Eve. only	3 months
I. Technical Writing	V-3 or equivalent	Eve. only	3 months
J. Computer Programming	High School Graduate	Day Evening Saturday	6 Weeks 24 Weeks 30 Weeks
K. Radio Code	8th Grade	Eve. only	As desired
L. Preparatory Math & Physics	1 Year High School	Day only	3 months
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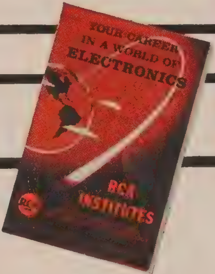

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A Service of Radio Corporation of America

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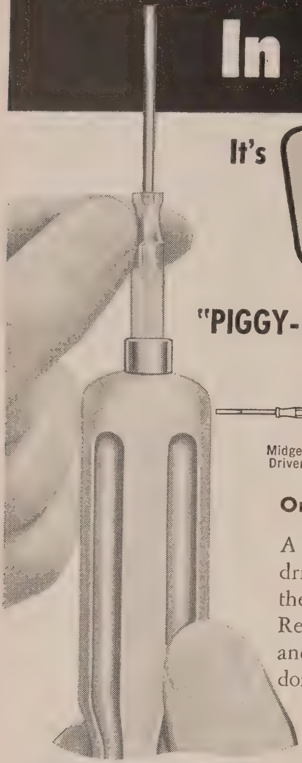


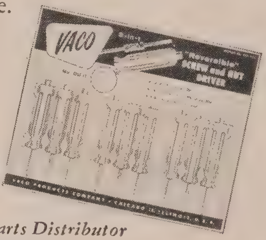
"PIGGY-BACK" SCREW DRIVER OFFER

Look What You Get!

Midget Driver
+
Handle with 1/4" Hex Socket
+
Reversible Blade with 3/16" Regular and No. 1 Phillips Bits

Only $1.28 complete (Dealer Net)

A regular Vaco instrument-type screw driver is included FREE in this deal with the purchase of a quality VACO DU-11 Reversible with dual purpose regular and Phillips bits and 1/4" hex socket on dome of handle.



Midget Driver FREE!
The midget driver handle, as illustrated, fits "piggy-back" into the hex socket of the DU-11 handle dome. This gives extra length and precision control when working in hard-to-get-at places.

Look for this display or ask your Parts Distributor for the VACO DU-11 "Piggy-Back" offer.

VACO PRODUCTS COMPANY
317 East Ontario Street, Chicago 11, Illinois

Mercury

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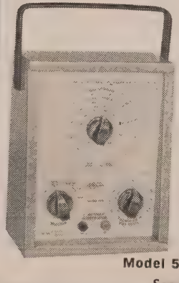

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Find the R, L and Z of IRON-CORE COILS

An ac voltmeter, a known resistor and a pencil and paper are all you need

By PAUL GHEORGHIU

THERE are several ways of measuring the resistance, inductance and impedance of an iron-core coil. Most of them require test instruments which may not always be on hand. This simple graphical method needs only a standard ac voltmeter, a single resistor, an ac source and a sheet of graph paper. The principle is not new, but seems to be little known.

Let's use as our example a choke whose R, L and Z are unknown. If we connect a pure resistance in series with it, we get an R-L circuit (Fig. 1).

Neglecting the dc resistance of the coil for the time, we measure voltage V_1 across the known resistor, V_2 the voltage across the choke and V_3 the source voltage. We can represent this in vector form by constructing a triangle with the voltages as edges (Fig. 2).

To construct the triangle, pick a convenient scale for voltage—one that will keep the triangle on the paper. Using the voltage across the resistor (V_1) as the horizontal reference, draw line OA equal to V_1. Using O as the

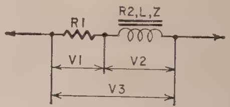
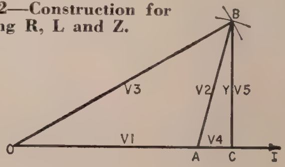


Fig. 1—Choke in series with fixed resistor. Voltage drops are indicated.

Fig. 2—Construction for finding R, L and Z.



center draw an arc with radius V_3. Then, using A as the center, draw another arc with radius equal to V_2. These arcs intersect at point B. From B, where the two arcs intersect, draw a perpendicular BC. Now AC and BC represent the voltage drops in the choke's resistance and inductance respectively.

Since the same current flows through the choke and resistor (we neglected the dc resistance of the choke), we get the coil resistance (R_2) and its inductance with the formula: $R_2 = \frac{V_4}{I}$

But since $I = \frac{V_1}{R_1}$, we can substitute $\frac{V_1}{R_1}$ for I and get $R_2 = \frac{V_4R_1}{V_1}$.

$L = \frac{V_5}{\omega I}$ or $\frac{V_5R_1}{\omega V_1}$ where $AC = V_4$, $BC = V_5$ and $\omega = 2\pi f$ (314 for 50 cycles, 377 for 60).

Once we have values for R and L we can calculate Z with the standard formula: $Z = \sqrt{R^2 + (\omega L)^2}$.

Example 1:

Calculate R, L and Z for the following values:

$V_1 = $ 50 volts (across resistor)
$V_2 = $ 113 volts (across coil)
$V_3 = $ 120 volts, 60 cycles
(2,500-ohm resistor in series with coil)

After construction (Fig. 3), the answer is:

$V_4 = 11$ volts $\quad V_5 = 112$ volts

$$R_2 = \frac{V_4R_1}{V_1} = \frac{11 \times 2,500}{50} = 550 \text{ ohms}$$

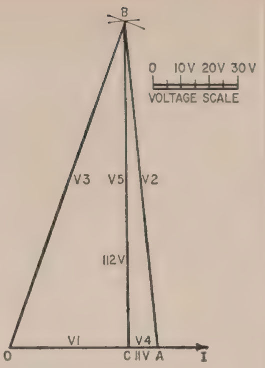


Fig. 3—Construction for example 1.

$$L = \frac{V_5R_1}{\omega V_1} \text{ or } \frac{112 \times 2,500}{377 \times 50}$$
$$= 14.9 \text{ henries}$$

$$Z = \sqrt{R^2 + (\omega L)^2}$$
$$= \sqrt{550^2 + (15 \times 377)^2}$$
$$= 5,685,$$

or approximately 5,700 ohms

Example 2:

Calculate the R, L and Z of a choke connected in series with a 1,000-ohm resistor. The series hookup is supplied with 120 volts ac at 50 cycles. Voltages across the resistor and choke are 80 and 66, respectively. Construction is

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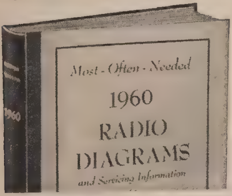

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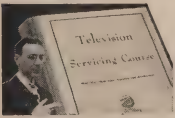

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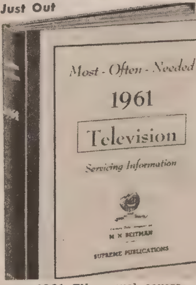

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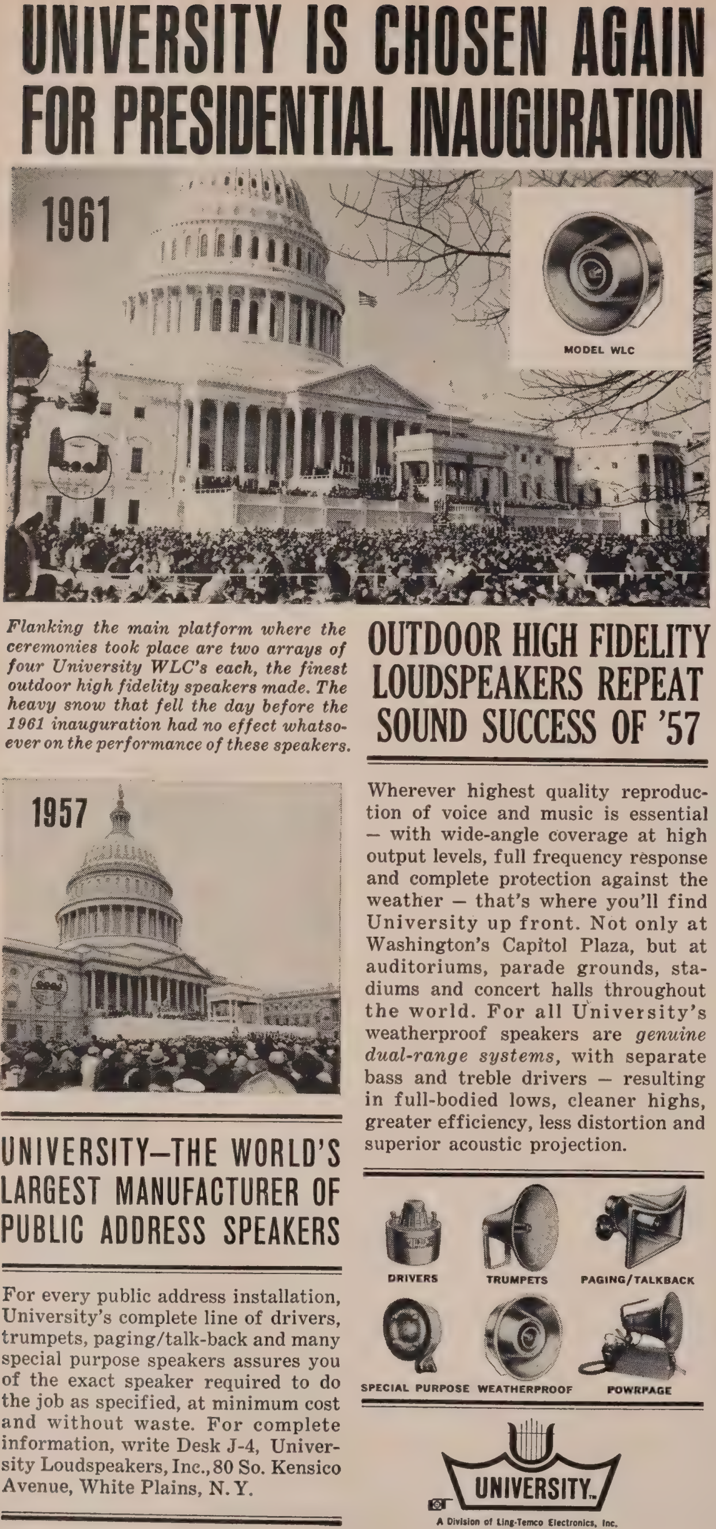

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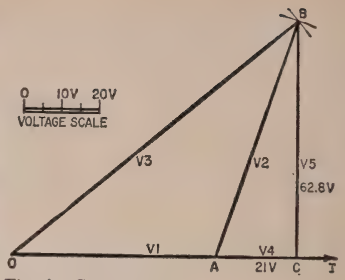

Fig. 4—Construction for example 2.

shown in Fig. 4. The triangle answer is: $V_4 = 21$ volts $V_5 = 62.8$ volts.

$$R = \frac{V_4R_1}{V_1} = \frac{21 \times 1{,}000}{80} = 262.5 \text{ ohms}$$

$$L = \frac{V_5R_1}{\omega V_1} = \frac{62.8 \times 1{,}000}{80 \times 314} = 2.5 \text{ henries}$$

$$Z = \sqrt{R^2 + (\omega L)^2}$$
$$= \sqrt{(262.5)^2 + (2.5 \times 314)^2}$$
$$= 827.7 \text{ ohms.}$$

Or approximately 825 ohms.

The degree of precision of this method depends on the relative value of resistance and reactance in the circuit as shown by the vector triangle. END

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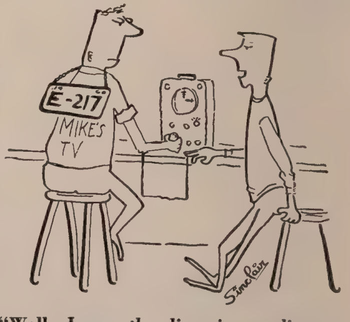

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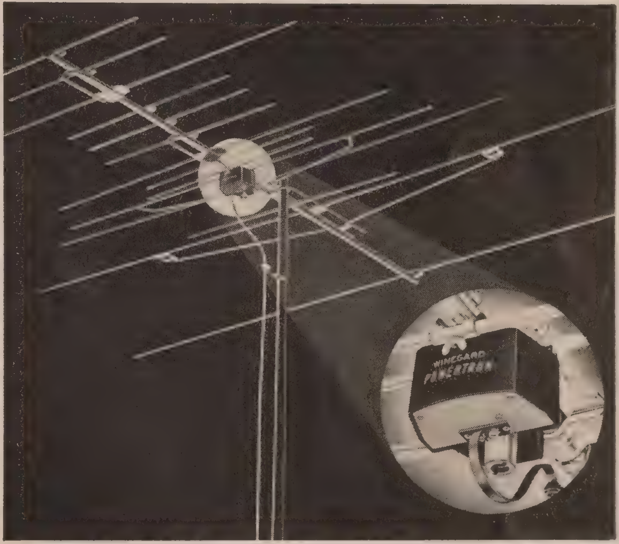

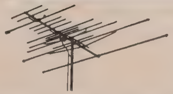

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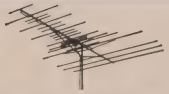

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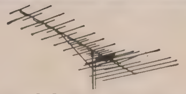

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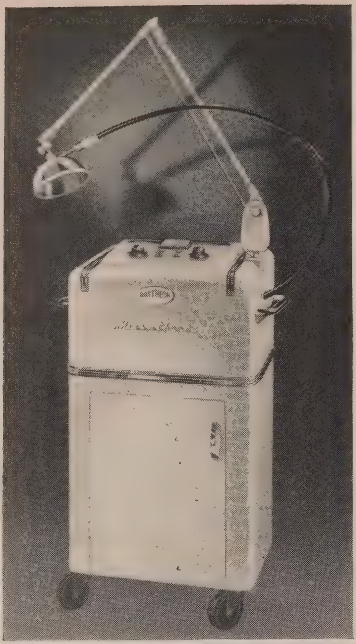

CASE of the RELUCTANT DIATHERMY

Tricky relays and tricked up circui
made this service job a toughie

By ED BUKSTEIN*

THE attractive receptionist smiled as Al Centauri introduced himself and explained that Dr. Brown had asked him to repair the diathermy equipment.

"Oh yes," she said pleasantly, "please be seated. Dr. Brown is with a patient now but he will see you in a few minutes." Al nodded his head in agreement and sank into a comfortable chair.

In a few minutes, as the receptionist had predicted, Dr. Brown came into the waiting room. After he and Al had exchanged greetings and a handshake, Dr. Brown stated his problem.

"We're having trouble with the diathermy apparatus. It doesn't seem to generate any power even with the control set to maximum. We had the same trouble about 2 months ago but the building maintenance man repaired it for us."

Al nodded again, but this time he made no attempt to look sympathetic.

"I'd appreciate it if you could get it fixed today," said the doctor, "I have a patient coming in for treatment tomorrow morning."

"I'll certainly try," promised Al.

"Thank you. Miss Anderson will show you where we keep the machine."

The patient awaits

Miss Anderson, the attractive receptionist, led the way down a long corridor. At the end of the corridor, she opened a door.

"Here's your patient," she said.

The diathermy unit stood against the wall as if defying Al to make it work. Somewhere in the deep recesses of Al's memory a tape machine switched to playback. *Diathermy—a method of heating the tissues of the body by rf energy—circuitry generally consists of a high-power oscillator and associated power supply—look out for HIGH VOLTAGE!*

Al stepped in for a closer look at the machine, a Raytheon Microtherm. The sloping top of the metal cabinet, about waist high, was the control panel: switches, pilot lights, controls and a meter for indicating output power. The chassis was in the top half of the cabinet, and the bottom half was used for storage. A coaxial cable coming out of the side of the cabinet terminated in a

dish-shaped director looking much li
a miniature radar antenna. This w
characteristic of microwave diatherm
and Al assumed that the oscillator tu
was a magnetron. There were sever
spare directors of different sizes a
shapes for treating various regions
the anatomy.

Al reached into his tool box a
pulled out a manilla folder, his file
diathermy equipment. This includ
some clippings, a few magazine articl
and some manufacturer's literatu
Among the items, fortunately, was
circuit diagram of the Microtherm (s
diagram).

"The circuit seems rather straigh
forward," Al mused. "A magnetr
oscillator operated with its pla
grounded and a high negative pote
tial applied to its cathode. A pair
866-A rectifiers in a full-wave circu
provides voltage for the magnetro
This voltage, variable over a range
1,000 to 1,500, is controlled by a Vari
in the primary circuit of the high-vo
age transformer. The circuit includ
a number of protective features:
blower for cooling the magnetron,
motor-driven time delay that allo
rectifier and magnetron filaments
reach operating temperature befo
high voltage can be applied, a 6.3-v
relay whose circuit is completed throu
the cable to the director prevents t
magnetron from operating without

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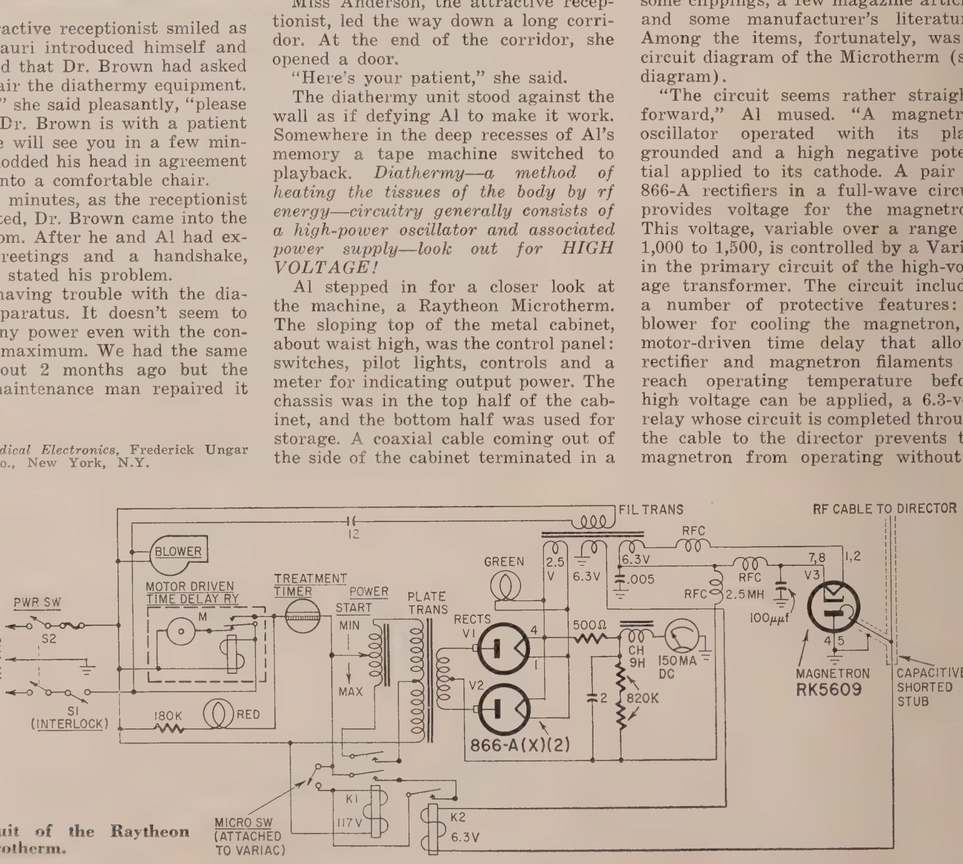
*Author: *Medical Electronics*, Frederick Ungar Publishing Co., New York, N.Y.



Circuit of the Raytheon Microtherm.

load, and a Micro Switch mounted on the power control Variac prevents application of high voltage until the control has been returned to its *minimum* position. The POWER switch (S2) applies power to the time delay motor, the blower and the filament transformer."

Let's give it a try

Al checked the machine to make sure that the power plug was in the outlet, the director and its cable were properly connected, and that the POWER control was set to its minimum position which was marked START. These things seemed to be in order so he flipped the power switch on. A green pilot lit up on the panel and Al could hear the blower motor start. He waited patiently while the time delay ran its course to preheat the rectifier and magnetron filaments. In about 3 minutes a red pilot lit up on the panel.

Presumably, the high voltage could now be applied. Since the 117-volt input is applied through the treatment timer, a spring-wound timing switch calibrated to 30 minutes, Al set the timer to 10 minutes and then gradually advanced the power control. The pointer of the output meter remained stubbornly at zero. He tried it again: returning the POWER control to START and then advancing it. Again the pointer refused to budge from its zero position. Al took another look at the schematic. A listing of possible causes flashed through his mind: defective magnetron, burned-out rectifiers, open transformer, defective relay, etc.

Al turned off the power, pulled the plug from the outlet and disconnected the coaxial cable from its connector at the side of the machine. He opened the door of the storage compartment in the bottom half of the metal cabinet and removed the bolts and wing nuts in the top of the compartment. The top half of the metal cabinet could now be lifted away from the bottom half, revealing the chassis still bolted to the bottom section.

Slowly circling the machine looking for any visible clues that might locate the defect, he noted with some concern that a length of bare wire had been wound around the terminals of the safety interlock switch. Entertaining some unflattering thoughts about the maintenance man the doctor had mentioned, he continued his search. Then he saw *it* on the underside of the control panel. A piece of tape had been wrapped around the Micro Switch to hold it closed. The tape, however, had dried out and one end had loosened, releasing the switch. His thoughts turned again to the maintenance man.

Mixed-up relays

After he had removed the dried-out tape, Al reconnected the coaxial cable, slipped the power plug into the outlet and turned on the power. In 3 minutes, the red pilot lit. As before, Al set the treatment timer and then gradually advanced the power control. The pointer of the power output meter clung to the zero marker. Leaving the power control in its advanced position, he again examined the machine for clues. The filaments of the 866-A rectifiers were lit, but there was no ionization glow. Now he examined the two relays. Relay K2 was energized, but relay K1 was not. Al felt a feeling of satisfaction sweep over him. He had repaired literally thousands of electronic devices, but the thrill of locating a defective component was still as fresh and pleasing as it was the very first time.

The misbehavior of the diathermy machine now became more meaningful: the contacts of relay K1 were used to connect the power control Variac to the primary of the high voltage transformer. Since the relay was not energized, there was no plate voltage available for the rectifiers and no high voltage for the magnetron.

To confirm his suspicions, Al pushed against the armature of relay K1 with the eraser end of a pencil. The rectifiers ionized with a bluish green glow, and the pointer of the output meter moved across its scale. When he removed the pencil, the armature of the relay moved back to its de-energized position, the rectifiers de-ionized, and the power output meter dropped back to zero.

Convinced that he was dealing with a burned-out relay, Al decided to turn off the power and make a resistance check of the relay coil. He moved the POWER control back to START and then relay K1 energized. When the feeling of surprise had subsided, Al admonished himself for jumping to conclusions. Now he returned his attention to the schematic and the haze began to clear from his brain.

"Relay K1 has two sets of contacts," he said to himself. "One set connects the Variac to the primary of the high-voltage transformer, and the other set is bridged across the Micro Switch through the contacts of K2. These holding contacts permit K1 to remain energized when the power control is advanced and the Micro Switch releases. Since the relay de-energizes when the power control is advanced, the holding contacts must be defective. Rather than replacing the relay, the maintenance man had taped the Micro Switch closed, repairing the symptom rather than the cause. Now that the tape has dried out and loosened, the symptom has reappeared."

Taking a flashlight from his tool kit, Al examined the holding contacts of the relay. They were indeed defective—blackened and badly pitted. He decided to replace the relay.

He returned in about an hour with a new relay, substituted it for the old one and tried the machine again. This time it worked properly. Relay K1 remained energized as the power control was advanced, and the power output meter responded normally. Al removed the piece of wire the maintenance man had wrapped around the terminals of the interlock switch, and then he replaced the top section of the metal cabinet. He stopped at the receptionist's desk on the way out.

"The patient has been cured," he said. "I'll send you my bill." END

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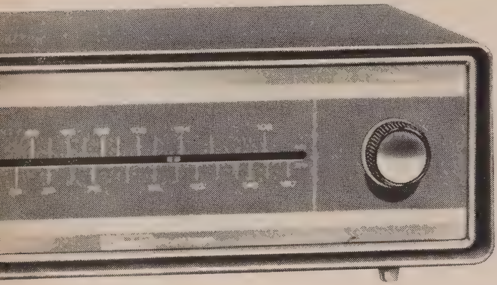

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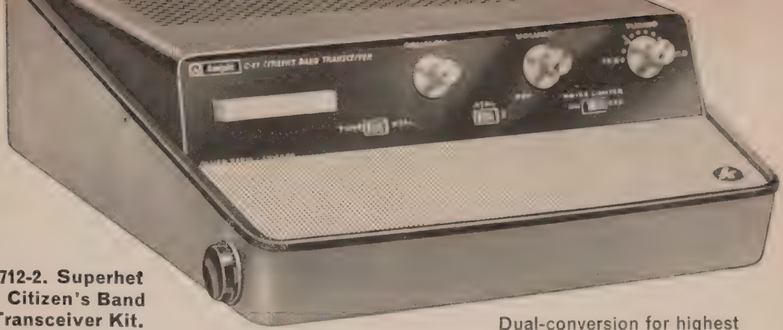

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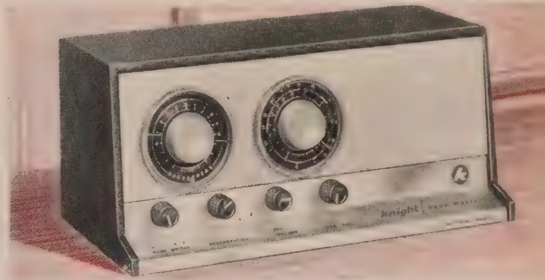

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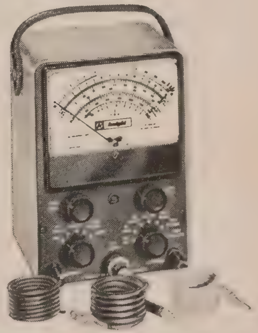

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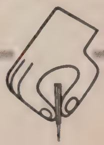

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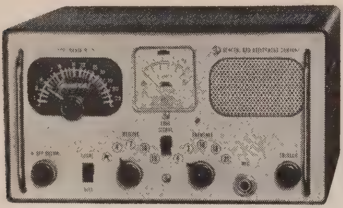

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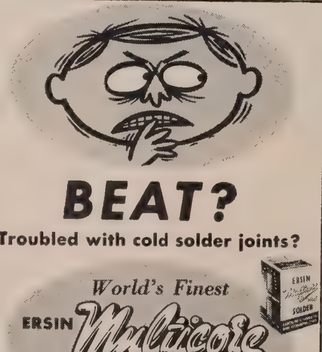

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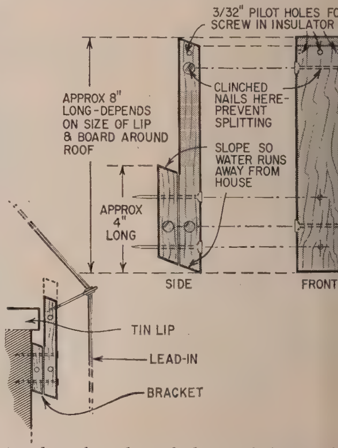
Don't throw away your rechargeabl 9-volt transistor radio battery if works intermittently or goes dead suc denly. I found that internal acid leak age had corroded the wire connection inside my battery (a Japanese Renax) I removed the top plate and the batter case, and soldered in new leads. Afte resealing with cellophane tape, the ba tery was as good as new.—*Leo Levit*

STANDOFF MOUNT

Many TV antennas are well installe mechanically and electrically except a the place where the lead-in comes o the roof and down the side of th house.

Sometimes the lead-in is run throug a hose or tubing and sometimes touches the edge of the roof (metal i many cases). But if a wood bracket i used (like the one shown here), th lead-in can clear the roof by 6 inche or any desired amount. The bracket are made of 1 by ¾-inch white pine o other soft wood. It is quicker to mak up a dozen or more at one time. Whe the bracket is painted the same colo as the board it's nailed to, it is not ver noticeable.—*Frank W. Dresser*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SCREW IN INSULATOR
APPROX 8" LONG-DEPENDS ON SIZE OF LIP & BOARD AROUND ROOF
CLINCHED NAILS HERE-PREVENT SPLITTING
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APPROX 4" LONG
SIDE
FRONT
TIN LIP
LEAD-IN
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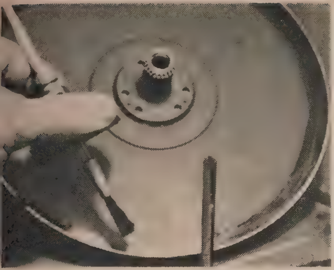
STOP TURNTABLE SLIP

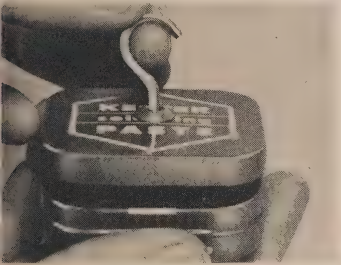
Frequently record players fail t operate because of a slipping turntable The motor pinion or driven idler whee slips against the inner rim of th



urntable, the turntable doesn't revolve ,t the proper speed and the changer nechanism may fail. If the turntable s removed, you will find that the inner urface on the flange of this disc is vorn smooth, causing the slippage. heck the spring tension on the idler vheel or on the motor pinion. If the ension is weak, this can also cause lippage. If this is not the trouble, oat the inner surface of the turntable lange with a preparation to prevent lippage. For this purpose ordinary ubber cement is recommended. It will emain tacky even after it hardens, nd will thus put an end to the slippage. ingernail lacquer will also work.—*len F. Stillwell*

FLUX-CAN HANDLE

You can have a trying time attempting to remove the lid from a can of oldering flux as there is no way to get good grip on it (especially if the outide of the can is fluxed up!). To solve his problem, screw a cup hook into he lid as shown.—*Charles A. Cunningam*



[If you must use soldering paste!—*ditor*]

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An electric hand power tool can be he solution to many electronic service roblems. For example, a small wire rush chucked in the tool can reach own in deep among parts and wires o clean a lug that's otherwise nearly mpossible to get at. Also, you can drill oles in hard-to-get-at places easier han you could with a hand drill. Every ime you have to tin your iron's tip, ou can put the wire brush to it and o the job in just a few seconds. Obviously, there are a dozen and one other andy time- and frustration-saving ses for one around the bench.—*Scott Mack*

END

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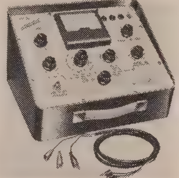

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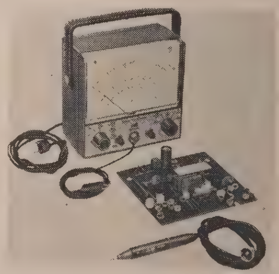

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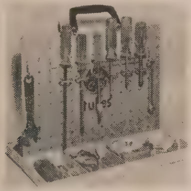

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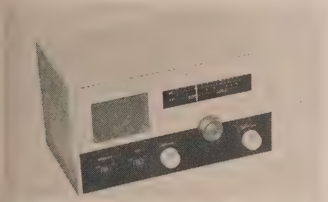

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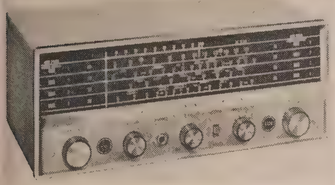

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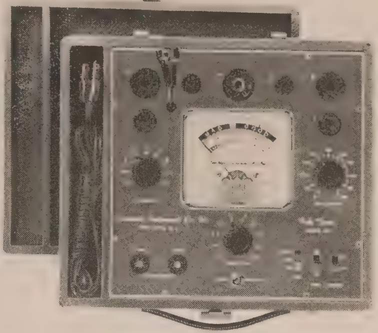

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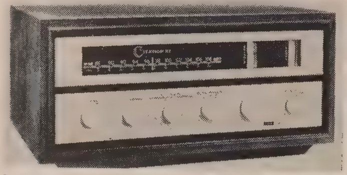
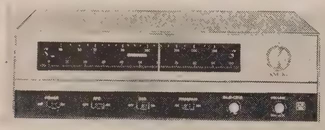
1⅝ in. 18 oz.—**Lafayette Radio**, 165-08 Liberty Ave., Jamaica 33, N. Y.

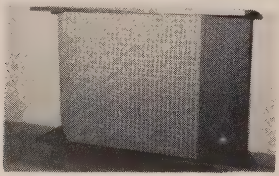
FM TUNER KIT, *Citation III.* Preassembled, prealigned FM cartridge includes second rf stage, mixer, oscillator, if sections and afc with regulated voltage supply. Nuvistor in first rf stage. 2 tuning meters. Multiplex output jack. Dual tuner output jacks. Interchannel muting. 10 tubes. 4 semiconductor diodes.—**Harman-Kardon, Inc.**, Ames Court, Plainview, N. Y.



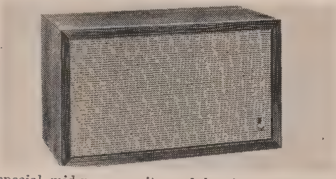
HI-FI FM TUNER, *KN-150.* Dynamic sideband regulation (DSR) for optimum reception of any FM station. Power for multiplex adapter included in circuit. IM distortion below 0.25% at signal levels over 10µv. 10 tubes. Chairside control through cathode-follower output permits tuner location up to 100 feet from amplifier.—**Allied Radio Corp.**, 100 N. Western Ave., Chicago.



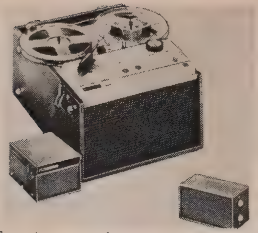
SPEAKER SYSTEM. 22 special 6-inch speakers and 6 hard-cone tweeters mounted on ? front and side-facing panels with four 6-inch speakers facing down on bottom of cabinet. Frequency response 30 cycles to 15 kc ±2 db. 25 watts before distortion; 88 watts peak. IM and harmonic distortion 1% at 100-db output. 29⅞ x 41¾ x 9½ in.—**Polycoustic Co.**, 958 Arguello Drive, San Leandro, Calif.



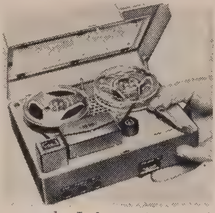
HIGH-FIDELITY LOUDSPEAKER SYSTEM, *model TF-3,* 4-speaker, 3-way, 10-inch woofer, 2 special mid-range units and hemispherical radiator for tweeter. 4 sides of cabinet furniture-finished for horizontal or vertical placement in oiled walnut. Also in unfinished gum hardwood.—**Jensen Manufacturing Co.**, 6601 S. Laramie Ave., Chicago 38, Ill.



TAPE RECORDER, *model KN-4100.* Either 3¾ or 7½ ips. Plays stereo tapes through any second available channel—hi-fi system, TV set, or recorder's matching KN-4150 accessory amplifier-speaker. Use "as is" as monophonic unit or tape deck for stereo music systems. Built-in stereo preamp.—**Allied Radio Corp.**, 100 N. Western Ave., Chicago 80, Ill.



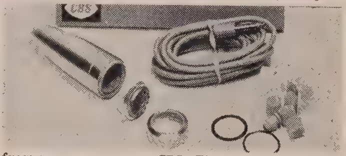
TAPE RECORDER, *RK-120.* Miniature, battery-operated. 7⅜ x 5¾ x 2½ in.; 4 lb. 5 transistors, 1 thermistor. Single function lever for rewind, stop, play, record.—**Lafayette Radio**, 165-08 Liberty Ave., Jamaica 33, N. Y.



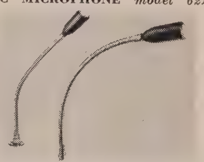
DEMAGNETIZER, *Magneraser: model 200C* for 100–130 volts; *model 220C* for 200–260 volts. Erases recorded signal completely on all tape brands, ¼- and ½-inch and 16- and 35-mm magnetic sound film and 5- to 15-inch plastic and metal reels.—**Amplifier Corp. of America**, 398 Broadway, New York 13, N. Y.

AMPLICORP
Magneraser Model 200C
AMPLIFIER CORP. of AMERICA
NEW YORK 13, NEW YORK

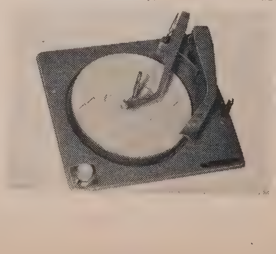
CERAMIC MICROPHONE KIT, *Mark III.* Sensitivity 52db below 1 volt/microbar at 1,000 cycles. 5-megohm recommended load. 30–10,000-cycles frequency response.—**CBS Electronics Div., Columbia Broadcasting System, Inc.**, Danvers, Mass.



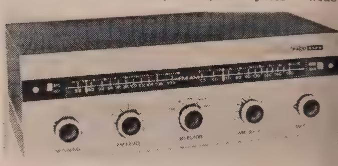
DYNAMIC MICROPHONE *model 624LL,* for language laboratories. Concealed cable. Adaptable mounting for fixed boom or flexible gooseneck.—**Electro-Voice, Inc.**, Buchanan, Mich.



RECORD CHANGERS, *AD-50* and *Deluxe AD-60.* Flutter and wow 0.18% rms or less. Turntable speed accurate within ±2%. Change cycle completed in 9 seconds. 4-pole, hum-shielded moto type. Friction drive. 2-gram tracking force. 10 record capacity. 13½ x 12 x 5½ inches above 3 inches below mounting board. *Deluxe AD-60* stereo–mono switch, intermixes 45- and 33⅓-rpm records.—**Heath Co.**, Benton Harbor, Mich.

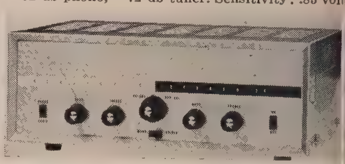


FM/AM STEREO TUNER. Kit or factory-wired Prewired, prealigned rf and if stages in both FM and AM sections. Frequency response 20–15,000 cycles for FM, 20–9,000 cycles "wide" (14kc), 20–4,500 cycles "narrow" (7kc) for AM.—**EICO (Electronic Instrument Co., Inc.)**, 33-00 Northern Blvd., Long Island City 1, N. Y.

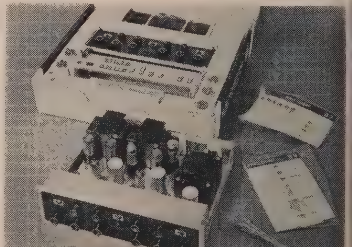


STEREO AMPLIFIER/PREAMP, *model S-5500* 50 watts. 15 front-panel controls and switches 12 inputs. Continuous power output 24 watts per channel. Hum and noise 80 db below 24 watts (radio) and 60 db below 24 watts (phono). Frequency response ±1 db 20 to 40,000 cycles per second. IM distortion 1½%. Continuous harmonic distortion ½% at 24 watts. Damping factor of 5. 4 x 14½ x 14.—**Sherwood Electronic Laboratories Inc.**, 4300 N. California, Chicago.

STEREO AMPLIFIER, *Realistic SAF-24.* Total rms distortion 400 cycles 1.8% at 12 watts. Hum —52 db phono, —72 db tuner. Sensitivity: .85 volt tuner, .004 magnetic cartridge. Tone controls ±7.5 db bass at 50 cycles, ±7.5 db. treble at 10,000 cycles. Feedback 18 db. Equalization ±1db RIAA. Tubes 2-12AX7, 4-6BM8, 1-6CA4. Outputs for 4-, 8- or 16-ohm speakers, auxiliary ac power. 8 inputs.—**Radio Shack Corp.**, 730 Commonwealth Ave., Boston 17, Mass.



STEREO AMPLIFIER KIT, *LK-72.* Kit-Pak, parts chart, full-color instruction book. Sharp-cutoff filter (12 db or sharper per octave) fully operative below 20 cycles prevents overloading of output stage and speaker from subsonic rumble frequencies and record eccentricity. Maximum power output each channel in music waveforms, 36 watts; in steady state, 30 watts. Maximum total harmonic distortion at rated output 0.8%. Frequency response 20 to 20 kc ±0.5 db. Power bandwidth at rated distortion (IHFM standards) 20 cycles to 20 kc. Inputs for high-, low-level magnetic pickups; tape, tuner.—**H. H. Scott Inc.**, 111 Powder Mill Rd., Maynard, Mass. END



All specifications from manufacturers' data.

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"I already own one. This is my second Mighty Mite." PHILCO DISTRIBUTOR, ST. LOUIS, MO.

"Mighty Mite has paid for itself the first month." W.C., UNIONTOWN, PA., TV REPAIR

"I have found the Mighty Mite all that you say it is and more. It tests tubes that my other tester, costing twice as much, will not test." L.K.E., W9PWQ, CHICAGO, HAM

In a nut shell... here's why the Mighty Mite finds them all. It checks tube grid circuits with the same high sensitivity as the indispensable Sencore LC3 Leakage Checker; yet it checks emission, leakage and shorts just like the big, expensive testers. That's why we call it the Mighty Mite . . . you can't miss!

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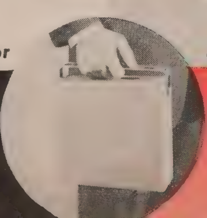
MAGAZINE TEST LABS SAY . . .

PF Reporter, Nov., 1960, page 65 . . .
"When putting the Model TC109 to work in the lab, I tried to 'trip up' the tester by throwing a few curves at it. Using my prized collection of rejected tubes that have mostly 'tough dog' defects, I proceeded with the tests given in the Sencore instructions." The results: The Mighty Mite found every trouble, even the toughest.

Les Deane

Electronics World, Jan., 1961, page 103 . . .
"We checked two dozen tubes known to be defective. Many had been passed as 'good' by other testers. Each failed at least one of the three tests provided by the TC109. On the other hand, every new tube previously known to be in good condition checked good on the Mighty Mite."

Your Distributor **has them in stock**



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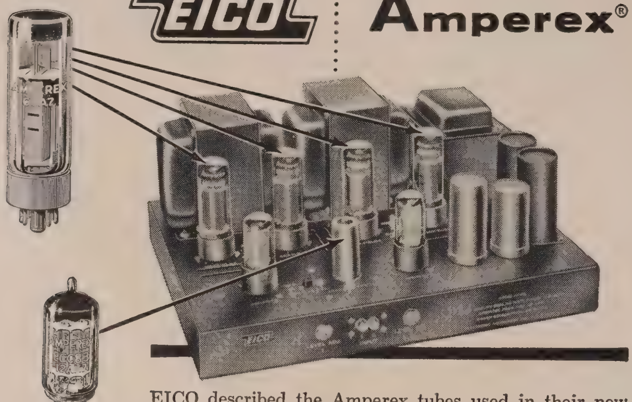
It's so easy to carry on every service call. The Mighty Mite is the smallest, most compact complete tester made. Smaller than a portable typewriter and with an all-steel case to protect it. Weighs less than 8 lbs.



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EICO described the Amperex tubes used in their new *HF89 100-Watt Stereo Power Amplifier* with the word, "unsurpassed." And with good reason. The *HF89* delivers 100 RMS watts undistorted from 20 to 20,000 cps. IM distortion at normal listening levels (even with low-efficiency speakers)... less than 0.1%!

To achieve these standards, EICO chose 4 Amperex 6CA7/EL34's for the *HF89's* output stage and 1 Amperex 12AX7/ECC83 for its voltage amplifier stage. The results: full-rated power output, inaudible distortion, low hum and noise, and the absence of microphonics.

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Write today for the *Audio Designers Handbook,* new 33-page booklet featuring 14 pages of complete schematics of mono and stereo preamplifiers and amplifiers. Price, $1.50. Amperex Electronic Corp., Special Purpose Tube Division, 230 Duffy Ave., Hicksville, Long Island, N. Y.

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POWER AMPLIFIERS
6CA7/EL34: 60 w. distributed load
7189: 20 w., push-pull
6BQ5/EL84: 17 w., push-pull
6CW5/EL86: 25 w., high current, low voltage
6BM8/ECL82: Triode-pentode, 8 w., push-pull

VOLTAGE AMPLIFIERS
6267/EF86: Pentode for pre-amps.
12AT7/ECC81: } Twin triodes, low
12AU7/ECC82: } hum, noise and
12AX7/ECC83: } microphonics
6BL8/ECF80: High gain, triode-pentode, low hum, noise and microphonics

RF AMPLIFIERS
6ES8: Frame grid twin triode
6ER5: Frame grid shielded triode
6EH7/EF183: Frame grid pentode for IF, remote cut-off
6EJ7/EF184: Frame grid pentode for IF, sharp cut-off
6AQ8/ECC85: Dual triode for FM tuners
6DC8/EBF89: Duo-diode pentode

RECTIFIERS
6V4/EZ80: Indirectly heated, 90 mA
6CA4/EZ81: Indirectly heated, 150 mA
5AR4/GZ34: Indirectly heated, 250 mA

INDICATORS
6FG6/EM84: Bar pattern
IM3/DM70: Subminiature "exclamation" pattern

SEMICONDUCTORS
2N1517: RF transistor, 70 mc
2N1516: RF transistor, 70 mc
2N1515: RF transistor, 70 mc
IN542: Matched pair discriminator diodes
IN87A: AM detector diode, subminiature

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DC Voltage: 0 to 7500 volts
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DC Current: 0 to 15 amperes
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Model 300 **$99⁷⁵** Net

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MERCURY ELECTRONICS CORP. 77 SEARING AVENUE, MINEOLA, NEW YORK

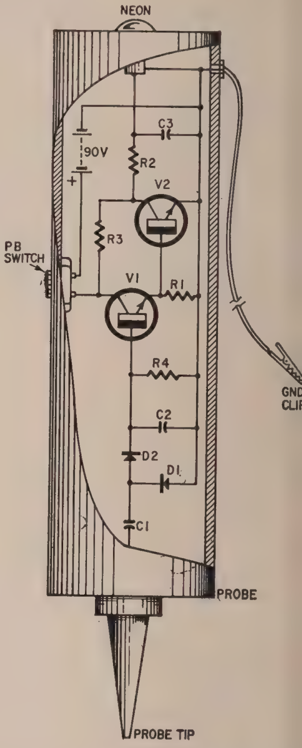
new PATENTS

PULSE INDICATOR

Patent No. 2,942,189

James J. Shea, Scotch Plains, Richard H. He berg, Warren Township, and Marshall R. Bog Point Pleasant, N. J. (Assigned to U.S.A. as resented by Secretary of Navy)

This probe indicates the presence of pu such as are derived from a multivibrator, ra TV sync generator, etc. The indicator is a bli ing neon lamp.



D1, D2 are silicon junction diodes. Posit pulses can pass through D2 to charge C2. Neg tive pulses charge C1 through D1, and in tu C1 will charge C2. In each case the volta across C2 increases conduction through V1. T signal is then applied to V2, which is driven lower conduction, raising the voltage across lamp.

C3 charges from the 90-volt source and at critical value it ignites the neon lamp. This d charges C3 and the cycle repeats as long pulses are present at the input.

This circuit can indicate 5-volt peak-to-pe pulses lasting as short as 0.2 μsec.

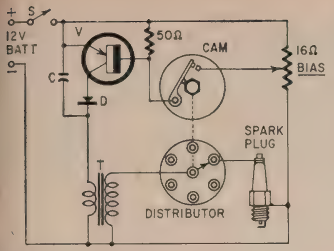
IGNITION SYSTEM

Patent No. 2,955,248

Brooks H. Short, Anderson, Ind., (Assigned General Motors Corp., Detroit, Mich.)

A high voltage is generated when curre through a large inductance is interrupted. internal combustion engine does it with break points on a cam, but these points wear quick because of arcing. In this invention, the poi carry a small current, the main flow bei switched by a transistor.

The diagram shows that only bias current carried by the points. When the contacts close, is biased to conduction and a large current flo into the primary of T. When the contacts ope



V is blocked. The energy stored in the coil cannot flow back through V because of diode D, so it charges C. The coil-capacitor combination forms an oscillatory circuit which prolongs the high voltage across T's primary.

The voltage is stepped up by the secondary, then fed through a distributor to spark plugs (one is shown).

Typical resistor values are shown. D should be rated at 10 amps and an inverse peak of 300 volts.

PHASE INDICATOR

Patent No. 2,957,137

Aaron Z. Robinson, Jr., Hyattsville, Md. (Assigned to USA as represented by Secretary of Navy)

Each transistor in this circuit (Fig. 1) remains blocked when its input goes negative. When *both* are blocked at the same time, point P goes positive (to the battery voltage). At all other times, at least one transistor conducts and P approaches ground potential.

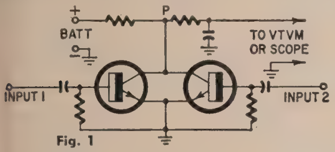


Fig. 1

Fig. 2 shows several conditions of phase difference. In the first, the signals are out of phase and one of them is positive at all times. At no time are both transistors blocked simultaneously so P remains at ground potential. In the second case (90° phase difference), P goes positive during the intervals when both signals go negative. In the last case, the signals are in phase. Both go negative simultaneously for half the time. The output is a symmetrical square wave.

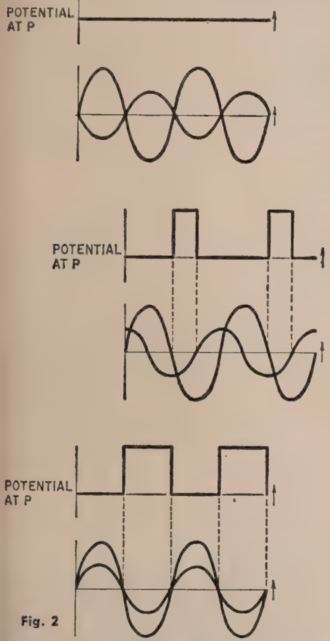


Fig. 2

The output pulse width varies with phase difference.
END

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FEATURES:

- Compact—measures 3⅛" x 5⅞" x 2¼".
- Uses "Full View" 2% accurate 850 Microampere D'Arsonval type meter
- Housed in round-cornered, molded case.

SPECIFICATIONS:

6 A.C. VOLTAGE RANGES: 0-15/30/150/300/1500/3000 Volts.

6 D.C. VOLTAGE RANGES: 0-7.5/15/75/150/750/1500 Volts.

2 RESISTANCE RANGES: 0-10,000 Ohms, 0-1 Megohm.

3 D.C. CURRENT RANGES: 0-15/150 Ma., 0-1.5 Amps.

3 DECIBEL RANGES: —6 db to + 18 db, + 14 db to + 38 db, + 34 db to + 58 db.

The Model 770-A comes complete with test leads and operating instructions. **Price is $15.85. Terms: $3.85 after 10 day trial then $4.00 monthly for 3 months.**

SUPERIOR'S NEW MODEL 79

SUPER-METER

WITH NEW 6" FULL VIEW METER

SPECIFICATIONS:

D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500.
A.C. VOLTS: 0 to 15/30/150/300/1,500/3.000.
D.C. CURRENT: 0 to 1.5/15/150 Ma. 0 to 1.5/15 Amperes.
RESISTANCE: 0 to 1,000/100,000 Ohms. 0 to 10 Megohms.
CAPACITY: .001 to 1 Mfd. 1 to 50 Mfd.
REACTANCE: 50 to 2,500 Ohms, 2,500 Ohms to 2.5 Megohms.
INDUCTANCE: .15 to 7 Henries, 7 to 7,000 Henries.
DECIBELS: —6 to + 18, + 14 to + 38, + 34 to + 58.

The following components are all tested for **QUALITY** at appropriate test potentials. Two separate **BAD-GOOD** scales on the meter are used for direct readings.

All Electrolytic Condensers from 1 MFD to 1000 MFD.
All Selenium Rectifiers. All Germanium Diodes.
All Silicon Rectifiers. All Silicon Diodes.

Model 79 comes complete with operating instructions, test leads and carrying case. **Price is $38.50. Terms: $8.50 after 10 day trial then $6.00 monthly for 5 months.**

SUPERIOR'S NEW MODEL 77

VACUUM TUBE VOLTMETER

WITH NEW 6" FULL VIEW METER

Compare it to *any* peak-to-peak V.T.V.M. made by *any* other manufacturer at *any* price!

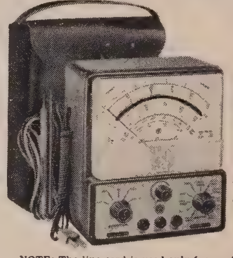
SPECIFICATIONS:

- **DC VOLTS**—0 to 3/15/75/150/300/750/1500 volts at 11 megohms input resistance.
- **AC VOLTS (RMS)**—0 to 3/15/75/150/300/750/1500 volts.
- **AC VOLTS** (Peak to Peak)—0 to 8/40/200/400/800/2000 volts.
- **ELECTRONIC OHMMETER**—0 to 1000 ohms/10,000 ohms/100,000 ohms/1 megohm/10 megohms/100 megohms/1,000 megohms.
- **DECIBELS**—10 db to + 18 db, + 10 db to + 38 db, + 30 db to + 58 db. All based on 0 db = .006 watts (6 mw) into a 500 ohm line (1.73v).
- **ZERO CENTER METER**—For discriminator alignment with full scale range of 0 to 1.5/7.5/37.5/75/150/375/750 volts at 11 megohms input resistance.

Model 77 comes complete with operating instructions, probe and test leads and carrying case. **Price is $42.50. Terms: $12.50 after 10 day trial then $6.00 monthly for 5 months.**

SUPERIOR'S NEW MODEL 80

20,000 OHMS PER VOLT ALLMETER



NOTE: The line cord is used only for capacity measurements. Resistance ranges operate on self-contained batteries.

6 INCH FULL-VIEW METER provides large easy-to-read calibrations. No squinting or guessing when you use Model 80.

MIRRORED SCALE permits fine accurate measurements where fractional readings are important.

SPECIFICATIONS:

7 D.C. VOLTAGE RANGES:
(At a sensitivity of 20,000 Ohms per Volt)
0 to 15/75/150/300/750/1500/7500 Volts.

6 A.C. VOLTAGE RANGES:
(At a sensitivity of 5,000 Ohms per Volt)
0 to 15/75/150/300/750/1500 Volts.

3 RESISTANCE RANGES:
0 to 2,000/200,000 Ohms. 0-20 Megohms.

2 CAPACITY RANGES:
.00025 Mfd. to .3 Mfd., .05 Mfd. to 30 Mfd.

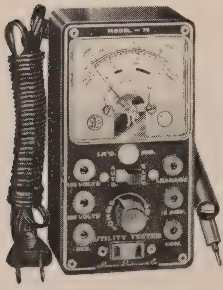
5 D.C. CURRENT RANGES:
0-75 Microamperes, 0 to 7.5/75/750 Milliamperes, 0 to 15 Amperes.

3 DECIBEL RANGES:
—6 db to +18 db, +14 db to +38 db, +34 db to +58 db.

Model 80 Allmeter comes complete with operating instructions, test leads and portable carrying case. **Price is $42.50. Terms: $12.50 after 10 day trial then $6.00 monthly for 5 months.**

SUPERIOR'S NEW MODEL 70 UTILITY TESTER

FOR REPAIRING ALL ELECTRICAL APPLIANCES MOTORS ★ AUTOMOBILES



UTILITY TESTER

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64 page condensed course in electricity. Profusely illustrated. Written in simple, easy-to-understand style.

As an electrical trouble shooter the Model 70:
• Will test Toasters, Irons, Broilers, Heating Pads, Clocks, Fans, Vacuum Cleaners, Refrigerators, Lamps, Fluorescents, Switches, Thermostats, etc. • Measures A.C. and D.C. Voltages, A.C. and D.C. Current, Resistances, Leakage, etc. • Incorporates a sensitive direct-reading resistance range which will measure all resistances commonly used in electrical appliances, motors, etc. • Leakage detecting circuit will indicate continuity from zero ohms to 5 megohms (5,000,000 ohms).

As an Automotive Tester the Model 70 will test:
• Both 6 Volt and 12 Volt Storage Batteries • Generators • Starters • Distributors • Ignition Coils • Regulators • Relays • Circuit Breakers • Cigarette Lighters • Stop Lights • Condensers • Directional Signal Systems • All Lamps and Bulbs • Fuses • Heating Systems • Horns • Also will locate poor grounds, breaks in wiring, poor connections, etc.

Model 70 comes complete with 64 page book and test leads. **Price is $15.85. Terms: $3.85 after 10 day trial then $4.00 monthly for 3 months.**

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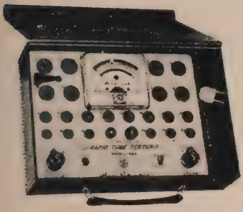
Then if completely satisfied pay on the interest-free terms plainly specified. When we say interest-free we mean not one penny added for "interest" for "finance" for "credit-checking" or for "carrying charges." The net price of each tester is plainly marked in our ads—that is all you pay except for parcel post or other transportation charges we may prepay.

SUPERIOR'S NEW MODEL 82A

MULTI-SOCKET TYPE TUBE TESTER



SPECIFICATIONS:

- Tests over 1000 tube types.
- Tests OZ4 and other gas-filled tubes.
- Employs new 4" meter with sealed air-damping chamber resulting in accurate vibrationless readings.
- Use of 22 sockets permits testing all popular tube types and prevents possible obsolescence.
- Dual Scale meter permits testing of low current tubes.
- 7 and 9 pin straighteners mounted on panel.
- All sections of multi-element tubes tested simultaneously.
- Ultra-sensitive leakage test circuit will indicate leakage up to 5 megohms.

Model 82A comes housed in handsome, portable, saddle-stitched Texon case. **Price is $36.50. Terms: $6.50 after 10 day trial then $6.00 monthly for 5 months.**

SUPERIOR'S NEW MODEL TW-11

STANDARD PROFESSIONAL TUBE TESTER

- Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin-number in the RMA base numbering system, the user can instantly identify which element is under test.
- Free-moving built-in roll chart provides complete data for all tubes. All tube listings printed in large-easy-to-read type.
- **NOISE TEST:** Phono-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.
- **SEPARATE SCALE FOR LOW-CURRENT TUBES**—Previously, on emission type tube testers, it has been standard practice to use one scale for all tubes. As a result, the calibration for low-current types has been restricted to a small portion of the scale. The extra scale used here greatly simplifies testing of low-current types.

The Model TW-11 comes housed in a handsome, portable, saddle-stitched Texon case. **Price is $47.50. Terms: $11.50 after 10 day trial then $6.00 monthly for 6 months.**

SUPERIOR'S NEW MODEL 83A

C.R.T. TESTER

Tests and Rejuvenates ALL PICTURE TUBES

ALL BLACK AND WHITE TUBES
From 50 degree to 110 degree types—from 8" to 30" types.

ALL COLOR TUBES
Test ALL picture tubes —in the carton —out of the carton —in the set!

Model 83A provides separate filament operating voltages for the older 6.3 types and the newer 8.4 types.

Model 83A properly tests the red, green and blue sections of color tubes individually—for each section of a color tube contains its own filament, plate, grid and cathode.

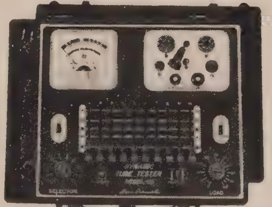
Model 83A will detect tubes which are apparently good but require rejuvenation. Such tubes will provide a picture seemingly good but lacking in proper definition, contrast and focus.

Rejuvenation of picture tubes is not simply a matter of applying a high voltage to the filament. Such voltages improperly applied can strip the cathode of the oxide coating essential for proper emission. The Model 83A applies a *selective* low voltage *uniformly* to assure increased life with no danger of cathode damage.

Model 83-A comes housed in handsome portable Saddle-stitched Texon case—complete with socket for all black and white tubes and all color tubes. **Price is $38.50. Terms: $8.50 after 10 day trial then $6.00 monthly for 5 months.**

SUPERIOR'S NEW MODEL 85

TRANS-CONDUCTANCE TYPE TUBE TESTER



- Employs latest improved **TRANS-CONDUCTANCE** circuit. Test tubes under "dynamic" (simulated) operating conditions. An in-phase signal is impressed on the input section of a tube and the resultant plate current change is measured as a function of tube quality. This provides the most suitable method of simulating the manner in which tubes actually operate in radio, TV receivers, amplifiers and other circuits. Amplification factor, plate resistance and cathode emission are all correlated in one meter reading.
- **SYMBOL REFERENCES:** Model 85 employs time-saving symbols (*, +, ●, ▲, ■;) in place of difficult-to-remember letters previously used. Repeated time-studies proved to us that use of these scientifically selected symbols speeded up the element switching step. As the tube manufacturers increase the release of new tube types, this time-saving feature becomes necessary and advantageous.
- **"FREE-POINT" LEVER TYPE ELEMENT SWITCH ASSEMBLY** marked according to RETMA basing, permits application of test voltages to any of the elements of a tube.
- **FREE FIVE (5) YEAR CHART DATA SERVICE.** Revised up-to-date subsequent charts will be mailed to all Model 85 purchasers *at no charge* for a period of five years after date of purchase.

Model 85 comes complete, housed in a handsome portable cabinet with slip-on cover. **Price is $52.50. Terms: $12.50 after 10 day trial then $8.00 monthly for 5 months.**

SUPERIOR'S NEW MODEL TV-50A

GENOMETER
7 Signal Generators in One!

- ✓ R.F. Signal Generator for A.M.
- ✓ R.F. Signal Generator for F.M.
- ✓ Audio Frequency Generator
- ✓ Bar Generator
- ✓ Cross Hatch Generator
- ✓ Color Dot Pattern Generator
- ✓ Marker Generator

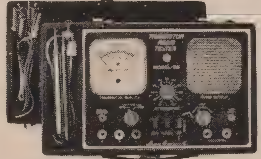
A versatile all-inclusive GENERATOR which provides ALL the outputs for servicing:

A.M. Radio • F.M. Radio • Amplifiers • Black and White TV • Color TV

The Model TV-50A comes absolutely complete with shielded leads and operating instructions. **Price is $47.50. Terms: $11.50 after 10 day trial then $6.00 monthly for 6 months.**

SUPERIOR'S NEW MODEL 88

TESTS ALL TRANSISTORS AND TRANSISTOR RADIOS



AS A TRANSISTOR RADIO TESTER

An R.F. Signal source, modulated by an audio tone is injected into the transistor receiver from the antenna through the R.F. stage, past the mixer into the I.F. Amplifier and detector stages and on to the audio amplifier. This injected signal is then followed and traced through the receiver by means of a built-in High Gain Transistorized Signal Tracer until the cause of trouble is located and pinpointed.

AS A TRANSISTOR TESTER

The Model 88 will test all transistors including NPN and PNP, silicon, germanium and the new gallium arsinide types, without referring to characteristic data sheets. The time-saving advantage of this technique is self-evident. A further benefit of this service is that it will enable you to test new transistors *as they are released!*

Model 88 comes housed in a handsome portable case. Complete with a set of Clip-on Cables for Transistor Testing; an R.F. Diode Probe for R.F. & I.F. Tracing; an Audio Probe for Amplifier Tracing and a Signal Injector Cable. Complete—nothing else to buy! **Price is $38.50. Terms: $8.50 after 10 day trial then $6.00 monthly for 5 months.**

Try any of the instruments on this or the facing page for 10 days before you buy. If completely satisfied then send down payment and pay balance as indicated on coupon. **No interest or Finance Charges Added! If** not completely satisfied return unit to us, no explanation necessary.

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Technotes

HOFFMAN REMOTE CONTROL

Accidental failure to ground the Aquadag coating on the picture tube can cause a lack of range on models equipped with remote control. This should be checked especially if the problem shows up after the chassis has been removed for service. The Aquadag coating is grounded on the various models as follows:

17-inch models: A ground strap with a clip on the end runs from the picture-tube mounting assembly to the tuner bracket. This must always be replaced after the chassis has been removed.

21-inch models: In addition to the ground strap as used in the 17-inch sets, there is an additional wire strap fastened to the chassis which contacts the Aquadag on top of the picture tube.

23-inch models. The Aquadag ground is the wire strap fastened to the top of the chassis. When the chassis is replaced, it is possible for this wire to get pushed down out of the way and thus not contact the Aquadag. Lift the wire and allow it to drop into position.—*Hoffman Tech Talk*

MAKE A DEGAUSSING COIL

Even though most color picture tubes have a special magnetic shield over the electron beam area, magnetic fields surrounding the picture tube can cause considerable color impurity. During transportation or storage, color receivers may be located in or near strong ac or dc fields from line transformers or power equipment that may magnetize the chassis or some of the metal brackets in the cabinet. These magnetic fields can be neutralized by introducing strong ac field and then gradually reducing it to nothing One way to do this without special equipment is to con struct a large coil that can be directly connected to th 117-volt ac line. We use a coil made up of 500-turns o No. 18 enameled wire formed around a 10-inch pictur tube. The entire coil is wrapped with electrical tape an the ends terminated in a 12-foot length of regular ac lin cord with plug.

The demagnetizing process is simple and performed wit the receiver in its cabinet. First the various convergenc and field neutralizing magnets are withdrawn from thei maximum effective positions. The next step is to hold th coil about 5 or 6 feet from the receiver, plug in the ac lin cord and slowly advance to the receiver. Pass the coil slowly over the front, rear and sides of the cabinet, then insid the cabinet at the sides and top of the assembly holding th picture tube. It is very important when demagnetizing color receivers to apply the demagnetizing field gradually at least 3 to 4 minutes should be devoted to the process Next the coil should be slowly withdrawn to the starting point and the ac line disconnected. Since the receiver i now completely demagnetized, all convergence and purity controls must be readjusted.—*Warren J. Smith*

AUTOMATIC ANTENNA REPAIR

Radio antennas on Lincolns use a long flat strip of nylon to raise and lower the antenna joints. The strip is operated by two grooved pulleys driven by an electric motor.

Most frequently, trouble is caused by the nylon strip kinking near its lower end, preventing it from passing through the pulleys on the upward travel of the antenna or entering the return tube as the antenna is pulled down.

When it's impossible to obtain another length of nylon and the kink is only a short distance from the lower end, a repair can often be made by cutting off the damaged part.

Such a repair may cause the top antenna joint to be a few inches shy on upward movement, but that is scarcely noticeable. There is also the possibility that the shortened nylon will be pulled past the pulleys on extreme upward travel,

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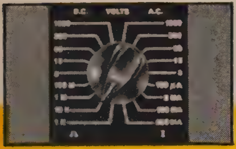

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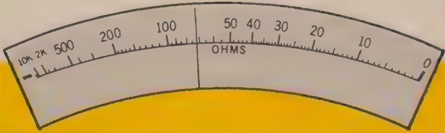

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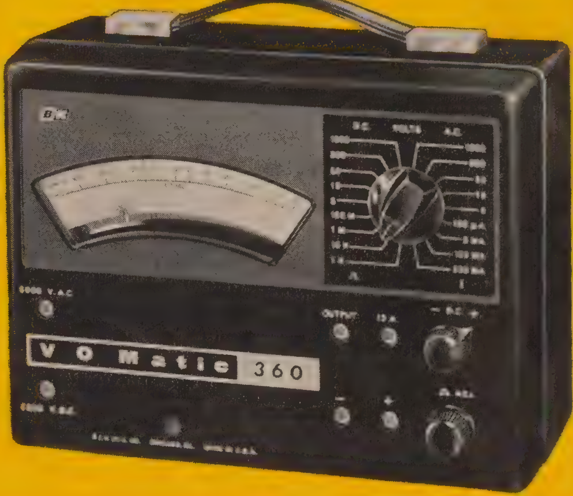

AUTOMATIC VOLT-OHM-MILLIAMMETER

- Individual Full-Size Scale for Each Range
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Once you set the range switch properly, *it is impossible to read the wrong scale.* Readings are easiest, fastest of all—so easy the meter "practically reads itself." Eliminates reading difficulties, errors, and calculations.

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Every scale in the V O Matic 360 is the same full size . . . *and only one scale is visible at any one time,* automatically. Supplemental ranges are also provided on separate external overlay meter scales.

This new-type automatic VOM is another innovation by B&K that gives you features you've always wanted. Outdates all others.

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DC Current — 0 - 100 μa, 5 ma, 100 ma, 500 ma, 10 amps
Resistance — 0 - 1000 ohms (3 Ω center)
0 - 10,000 ohms (50 Ω center)
0 - 1 megohm (4 k Ω center)
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The Progressive Radio "Edu-Kit" is the foremost educational radio kit in the world, and is universally accepted as the standard in the field of electronics training. The "Edu-Kit" uses the modern educational principle of "Learn by Doing." Therefore, you will construct radio circuits, perform jobs and conduct experiments to illustrate the principles which you learn.

You begin by examining the various radio parts included in the "Edu-Kit." You then learn the function, theory and wiring of these parts. Then you build a simple radio. With this first set, you will enjoy listening to regular broadcast stations, learn theory, practice testing and troubleshooting. Then you build a more advanced radio, learn more advanced theory and techniques. Gradually, in a progressive manner, and at your own rate, you will find yourself constructing more advanced multi-tube radio circuits, and doing work like a professional Radio Technician.

Included in the "Edu-Kit" course are twenty Receiver, Transmitter, Code Oscillator, Signal Tracer, Signal Injector, Square Wave Generator and Amplifier circuits. These are not unprofessional "breadboard" experiments, but genuine radio circuits, constructed by means of professional wiring and soldering on metal chassis, plus the new method of radio construction known as "Printed Circuitry." These circuits operate on your regular AC or DC house current.

In order to provide a thorough, well-integrated and easily-learned radio course, the "Edu-Kit" includes practical work as well as theory; troubleshooting in addition to construction; training for all, whether your purpose in learning radio be for hobby, business or job; progressively-arranged material, ranging from, simple circuits to well-advanced topics in Hi-Fi and TV. Your studies will be further aided by Quiz materials and our well-known FREE Consultation Service.

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You will receive all parts and instructions necessary to build 20 different radio and electronics circuits, each guaranteed to operate. Our Kits contain tubes, tube sockets, variable, electrolytic, mica, ceramic and paper dielectric condensers, resistors, tie strips, coils, hardware, tubing, punched metal chassis, Instruction Manuals, hookup wire, solder, selenium rectifiers, volume controls, switches, knobs, etc.

In addition, you receive Printed Circuit materials, including Printed Circuit chassis, special tube sockets, hardware and instructions. You also receive a useful set of tools, a professional electric soldering iron, and a self-powered Dynamic Radio & Electronics Tester. The "Edu-Kit" also includes Code Instructions and the Progressive Code Oscillator, in addition to the F.C.C.-type Questions and Answers for Radio Amateur License training. You will also receive lessons for servicing with the Progressive Signal Tracer and the Progressive Signal Injector, and a High Fidelity Guide and Quiz Book. Everything is yours to keep.

J. Statatis, of 25 Poplar Pl., Waterbury, Conn., writes: "I have repaired several sets for my friends, and made money. The "Edu-Kit" paid for itself. I was ready to spend $240 for a Course, but I found your ad and sent for your Kit."

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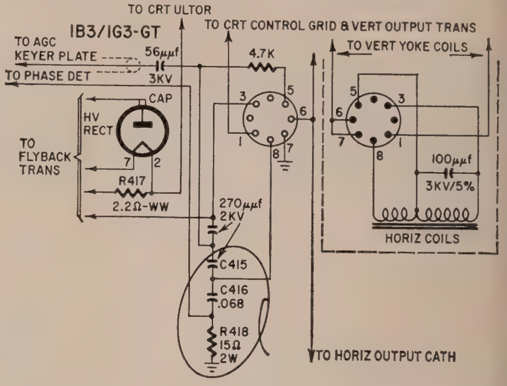
but that can be prevented by stapling the lower end and passing a few turns of copper wire of small size through the staple to serve as a stop.—*Henry Josephs*

1960 HOFFMAN TV's

Excessive width on a receiver using the 23-inch tube can be decreased by adding a 0.1- or 0.15-μf 600-volt capacitor across C416. (See partial schematic.) The late runs of the 23-inch models have a width switch installed. It varies the capacitance of C416 from .05 to 0.22 μf.—*Hoffman Tech Talk*



RCA 6-X-5 SERIES

A number of these receivers have come into the shop with the same intermittent condition. The first was more or less a toughie but the following ones were fairly simple since we knew what to look for. The receiver would operate perfectly until the volume was turned up or the set was jarred. New tubes were substituted, but the trouble persisted. Then a close check was made for a break in a connector or a loose connection on the printed-circuit board, but no such fault was uncovered. Carefully wiggling the various parts, we found that one if transformer seemed to be more sensitive to movement than the other components. Removal and closer inspection revealed that excess solder had flowed up around the leads to the transformer windings. The intermittent occurred when jarring or vibration from the speaker caused the leads to contact this excess solder, which was in turn grounded through the transformer can. Cleaning off all excess solder in and around the if transformers cured the intermittent.—*Warren J. Smith*

ZENITH MODEL Z1816C

Complaint: No picture, no sound, raster normal.

Cure: If a burning odor is present, check for a shorted 6AQ5 audio output tube. This is rather common in this model, and the shorted 6AQ5 generally burns out the 440-ohm cathode resistor. The 125-volt B-plus comes off this point and is fed to the video and audio tubes. The open cathode resistor kills the B-plus and the sound and picture go with it.—*John B. Ledbetter* END

new LITERATURE

Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufacturers, whose addresses are listed at the end of each item. Use your letterhead—do not use postcards. To facilitate identification, mention the issue and page of RADIO-ELECTRONICS on which the item appears. UNLESS OTHERWISE STATED, ALL ITEMS ARE GRATIS. ALL LITERATURE OFFERS ARE VOID AFTER SIX MONTHS.

CARTOONS spoof the new age and its world of computers, automation and missiles in a 24-page *Further Studies in Space-Age Psychology.*—**Audio Devices Inc.**, 444 Madison Ave., New York 22, N. Y.

SERVICE PRODUCTS for the electronics industry, including phono drives, exact replacement transformers, tools, chemicals and electronic hardware, described and illustrated in 68-page *Catalog FR-61-W.*—**Walsco Electronics Mfg. Co.** (Div. of Textron Electronics, Inc.), Rockford, Ill.

IMPEDANCE MATCHING IN PUBLIC-ADDRESS SYSTEMS is thoroughly explored in *Installation Sheet IS-800* with help of instructive text and 22 figures. Its 12 pages deal with such problems as methods of connecting speakers to amplifiers, loudspeaker matching with high-impedance lines, constant-voltage distribution systems, line-matching transformers and the control of loudspeaker levels.—**Bogen-Presto**, Post Office Box 500, Paramus, N. J.

MINOR TUNE-UP WITH IGNITION ANALYZERS is a basic course intended to provide the reader with the minimum know-how of testing, locating and correcting minor problems. 45 pages with ample illustrations of instruments, testing patterns and step-by-step repairs.—**Heath Co.**, Subsidiary of Daystrom Inc., Benton Harbor, Mich., $2.

ELEMENTARY BINARY ARITHMETIC is examined in *Aerovox Research Worker*, Vol. 30, Nos. 7, 8 and 9. 4-page booklet opens with the rudiments of the system, continues through binary addition, subtraction and multiplication and concludes with binary notation in a 4-device system.—**Aerovox Corp.**, New Bedford, Mass.

STEREO HI-FI GUIDE for 1961 outlines complete product data and prices on wide variety of amplifiers and preamplifiers, tuners, turn tables, arms, cartridges, speakers and speaker systems, microphones, tape recorders and hi-fi accessories. 100 pages.—**Airex Radio Corp.** 64 Cortlandt St., New York 7, N. Y.

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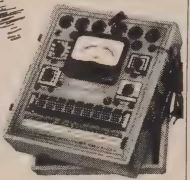

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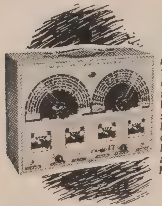

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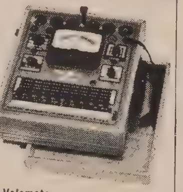

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TRANSISTOR GUIDE for switching circuit designers, *Application Lab Report 691*, covers manufacturer's line of switching transistors and their particular uses. A chart grouping transistor characteristics, tables and 18 figures showing typical circuits are included. Handy list of definitions concludes brochure.—**Philco Corp.,** Lansdale Div., Church Rd., Lansdale, Pa.

PORTABLE TRANSCRIPTION PLAYERS *VP-20* and *VP-40* are reported on in 6-page *Catalog No. 702. Specification Sheets ES-VP-20* and *ES-VP-40* give complete technical information, accessories, and schematic diagrams.—**Bogen-Presto, Div. of Siegler Corp.,** PO Box 500, Paramus, N. J.

INSTRUMENT TUBE *Brochure PA-391* describes characteristics and uses for tubes made specifically for instrument manufacturers as well as some framegrid and secondary-emission tubes. 8 illustrated pages.—**CBS Electronics,** Technical Information Services, 100 Endicott St., Danvers, Mass.

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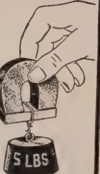

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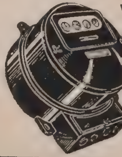

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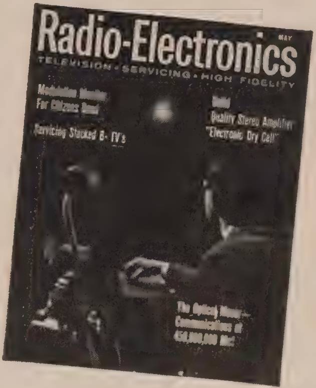

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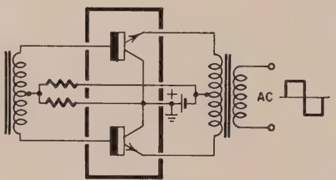
A double transistor that combines two identical n-p-n silicon units that share a common collector. It is well suited to ac-to-dc converters and dc choppers. Typical circuits using these units in this way are shown in Figs. 1 and 2.



DC-AC CONVERTER
Fig. 1

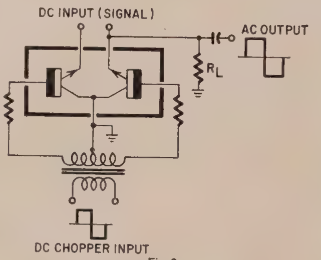


Fig. 2

As the twin transistors are united in production and undergo almost identical stress, temperature, environment and other conditions critical to their manufacture, they have very similar electrical and thermal properties.

A unique feature in the construction of these transistors is that all the electrically active areas are inside the semiconductor crystal from which they are made. In this way, the active areas are protected by the skin of the crystal itself (Fig. 3). To quote RCA, "It's something like building a model ship inside a glass bottle and then plugging the bottleneck permanently."

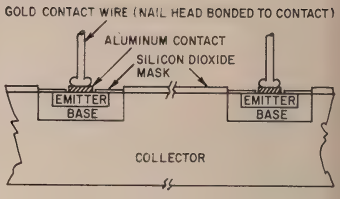


Fig. 3

Now listed as a developmental unit, there are two versions—the TA-2044A and TA-2044.

Developmental characteristics of these units are:

	TA-2044A	*TA-2044*
Collector breakdown (volts)	25	25
Emitter breakdown (volts)	5	5
Offset voltage balance (μv)	100	300
Collector leakage (μa)	.01	.01
Emitter leakage (μa)	.01	.01
Beta (minimum)	30	30

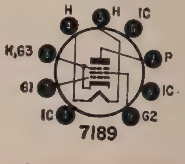
7189

A power-pentode in a 9-pin miniature envelope designed for push-pull power-amplifier circuits of high-fidelity audio equipment. It is especially useful in combination TV–radio–audio systems where compactness without sacrifice of high-fidelity performance becomes essential.

The RCA 7189 features a maximum plate dissipation of 12 watts and unusually high power sensitivity. Because of the latter feature, it can deliver high power output with small driving voltage. For example, two 7189's in class-AB1 push-pull amplifier service can deliver a maximum-signal power output of 24 watts with a peak driving voltage of only 14.8.

Typical operating characteristics in push-pull af power amplifier service, with fixed bias, class AB1 are (values are for 2 tubes):

V_P (plate voltage)	400
V_{G2} (grid 2 voltage)	300
V_{G1} (grid 1 voltage)	−15
(peak audio)	14.8
I_P (plate current)	
(zero signal) (ma)	15
(max signal) (ma)	105



7189

I_{G2} (grid 2 current)	
(zero signal) (ma)	1.6
(max signal) (ma)	25
R_L (load resistance)	
(plate-to-plate) (ohms)	8,000
HM_{total} (total harmonic distortion)	4%

ORP 50

A light-sensitive cadmium sulphide cell, the ORP 50, is both top- and side-sensitive. The double sensitivity is gained by positioning the cadmium sulphide area at a 45° angle. The all-glass hermetically sealed unit can be used for applications such as flame control, industrial on–off switching, relays, automatic counting and level and density control.

Amperex
ORP 50

The Amperex cell is 0.63 inch in diameter and 1.42 inches long. Maximum dissipation is 250 mw. Average cell current is 10 ma.

Frame-grid tubes

Five miniature frame-grid tubes featuring high transconductance and low noise, have been announced by Raytheon's Industrial Components Div. The frame grid approaches the ideal control surface within the tube, providing higher gain and lower noise than was possible with conventional tubes.

The tubes and their transconductances are: 6939, a double tetrode, 10,500 μmhos per section; 6688, a pentode, 16,500 μmhos; 6922, a twin diode, 12,500 μmhos per section. 5842, a triode, 25,000 μmhos; and the 5847, a pentode, 13,000 μmhos.

Applications include use in rf amplifiers, if amplifiers, driver stages, cathode followers, cathode amplifiers. END

◆

CORRECTION
The Elusive 2N247

The 2N247 transistor used in the 10-meter transceiver and the Citizens-band paging receiver (pages 51 and 62, respectively, of the January issue) is in short supply and may be difficult to obtain. RCA and Sylvania discontinued the 2N247 quite some time ago but continue to carry it on price sheets as late as December, 1960. It is listed in 1961 mail-order catalogs. Both manufacturers have replaced the 2N247 with improved types. The RCA equivalent is the 2N1632, and the Sylvania replacement is the 2N1673.

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✓ Also provides the newer 2.35 and 8.4 filament voltages

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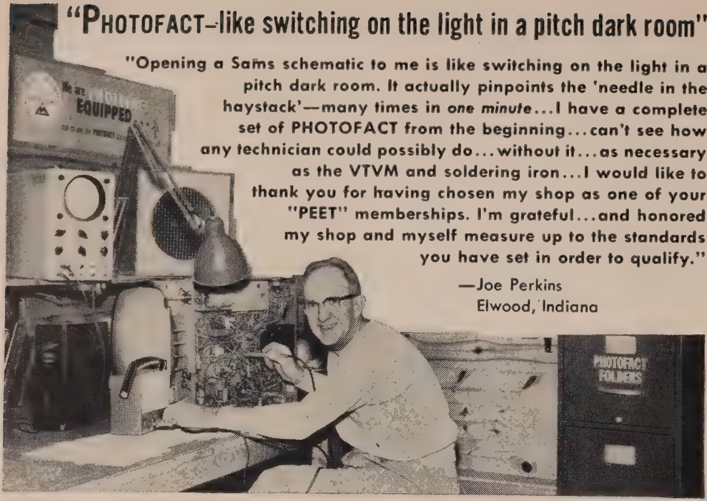

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Elwood, Indiana

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TECHNICIANS' NEWS

ELECTION RETURNS

Buffalo, N. Y.—The Western New York Electronics Guild of Buffalo elected officers for 1961:

President, Fred DiTonde; vice president, Lester Marschall; secretary, Elmore Bement; treasurer, Clarence Thielke; sergeant at arms, Edward Twardy; executive committee, James Archibald and Jack McDonough.

TECHNICIANS' HEARTACHE

One more tale of the "wholesale house." Happened to be in one a few days ago. Well-dressed gent—obviously not on service business—dropped a phono cartridge on the counter and asked the store manager if he had one like it. After some checking back and forth, he came up with the proper unit and started to make out a sales ticket. Just in time, he noticed a couple of local service technicians looking on with interest, so he asked the chap who the cartridge was to be billed to. "Me" was the answer. So the wholesaler graciously asked the two legitimate customers which one wanted to sell the cartridge. One of them told him, "Oh, just go ahead and bill it like you would have if we hadn't been here." His confusion was amusing, but by no means funny. — *The Printed Circuit,* High Point, N. C.

CESA-PASADENA MEETS

Pasadena, Calif.—The California State Electronics Association held its first meeting of the year at Vasa Hall. The main business of the day was the appointment of the Nominations Committee—election time is rolling around again. Then reports from two council meetings were presented.

OFFICERS FOR 1961

Harrisburg, Pa.—The Federation of Television-Radio Service Associations of Pennsylvania, Inc. met at the Hotel Harrisburger to select its officers for 1961.

Those named were: president, Wayne Prather of Harrisburg; vice president, Bert Bregenzer, Pittsburgh; recording secretary, Clarence Eck, Allentown; corresponding secretary, Leon J. Helk, Carbondale, and treasurer, L. B. Smith, Hershey.

Joseph Doyle of Pittsburgh, chairman of the License Bill Committee for State Licensing, issued plans for members and nonmembers to aid in the promotion of House Bills 838-839 that will be presented to the State Legislature next session.

The federation's stand regarding pay television or subscription TV was reviewed, since it had been erroneously quoted earlier.

The federation does not oppose pay TV, but would oppose any monopolistic service practices by any and all interests that would tend to make the new system a captive one.

NEW PUBLICATION

The Electronic Service Association of Butte, Mont., is putting out a two-page newspaper called *E. S. A. Pulses.* Congratulations.

TWO MORE ASSOCIATIONS

Two more service associations have asked to include their names in the RADIO-ELECTRONICS TV Service Association Listing:

Association of Independent Servicemen of Iowa
Graydon B. Martin
East Des Moines Station, Box 104
Des Moines, Iowa

The group has a publication called *The Scope of Iowa.*

The second group to contact us was:

Certified Electronic Technicians Association
Sol Fields, Corresponding Secretary
189 Lincoln Avenue
Island Park, N. Y.

Their current officers are:

President, Al Schaw; vice president, Frank Joseph; corresponding secretary, Sol Fields; recording secretary, Hy Brandeis; treasurer, John McManmon; sergeant at arms, Graham Holzhausen.

90-DAY PARTS AND LABOR GOOD OR BAD?

It seems to depend on the section of the country the technician works in. Some say it has good features, most feel it can only do harm.

Two TV manufacturers have introduced 90-day parts and labor warranties with their new TV receivers. Here are the reactions of technicians across the country, according to *Home Furnishings Daily.*

California:

Some groups for and others against. Those for the warranty feel that it would not work against the interests of independent service technicians. Those against say that any form of free service hurts their business. They also ask what the manufacturer is going to do the first time a technician has trouble tracking down a fault and bills the manufacturer for more than the company makes on the set? They won't like it and the next thing you know, they will want to handle their servicing themselves.

Illinois:

NATESA is opposed in principle to any warranty on labor.

Indiana:

Opposition to any free service offer is backed by the Indiana Electronic Service Association. The group is afraid that free service deals will spread and warranty time limits will be extended.

Maryland:

The warranties are unrealistic and will hurt the independent service technician. Record-keeping will also create a problem.

Massachusetts:

Wait and see, but afraid that other manufacturers will climb on the bandwagon.

Michigan:

Another vote against. Technicians feel that the manufacturers rates for free warantees do not cover dealers costs.

Minnesota:

Split decision. Better than extended parts warranty, but may be first step into a factory service operation.

Missouri:

Mostly against. The fee the factory will pay the technician is too low. The Television Service Association of Missouri says, "We don't go along with any free labor program."

New York:

Opposed to all forms of captive service which might cut into the business of the independent service technician.

North Carolina:

Is probably most helpful to dealers that do not have service departments.

Ohio:

Independent technicians against the plan. While not considering it a current threat, technicians are afraid of possible growth of such a plan with the manufacturers setting the price of repairs.

Pennsylvania:

Not worried too much by this plan but concerned that manufacturers might decide to extend such offers to cover longer periods of time.

Wisconsin:

Ninety days is reasonable period, but if time should be extended, say to a year, profits would be affected.

CALIFORNIA AND LICENSING

Los Angeles, Calif.—A TV service licensing bill has been introduced in the state assembly. According to *Home Furnishings Daily,* it is reportedly supported by 47 of the 80 assemblymen.

The bill, No. 265, would set up a regulatory board under the California Business and Professions Code establishing standards for these industries. The bill is sponsored by the California State Electronics Association Inc., and the Appliance Profession Association.

GROUP ADVERTISING

Buffalo, N. Y.—The Television & Electronic Service Association of Greater Buffalo is boosting its members with newspaper advertising.

The ad lists the phone numbers of all association members and stresses that these shops are qualified to repair any make of TV receiver and that all repair jobs made by these shops are guaranteed by the association. The association shield, which each member displays in his window, also appears in the ad.

ISSUE 46 MORE LICENSES

Niagara Falls, N. Y.—Applications by 46 service technicians and service dealers were approved by the Television Board of Examiners for 1961. The total number of licenses issued to date is 92. This total is broken into three categories—technician, service dealer and combined dealer-technicians. END

IMPORTANT NEW SAMS BOOKS

ALL YOU WANT TO KNOW ABOUT CB RADIO!

Citizens Band Radio Handbook

by David E. Hicks

A practical guide to Citizens Band radio for owners, prospective owners and technicians. Tells how to get a license and select equipment. Fully describes CB circuits, antennas, installation, operating procedures, troubleshooting and maintenance. PLUS VALUE—included at no extra cost to you are complete FCC rules and regulations all CB licensees *must* have on hand. It's the *complete* book on CB radio. 192 pages; 5½ x 8½". *Only*............... $2.95

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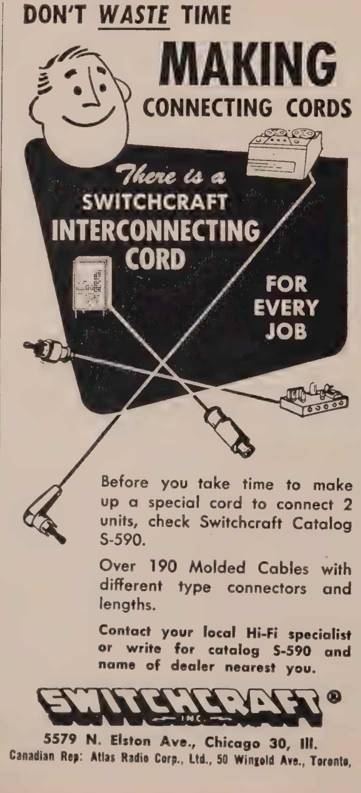
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new BOOKS

EXPERIMENTS IN INDUSTRIAL ELECTRONICS, by Melvin Whitmer. Howard W. Sams & Co. Inc., 1726 E. 38 St., Indianapolis, Ind. 5½ x 8½ in. 94 pp. $1.95.

This book can help radio–TV technicians extend their knowledge to industrial controls and measurement. It shows how you can make and understand devices utilizing rf heating, photoelectricity, timers, proximity detectors, servos, etc. Complete layouts, photos and step-by-step tests are included. To hold the cost to a minimum, the author uses the same parts in several projects.

The first chapter lists industrial symbols which are used thereafter.—*IQ*

THE SOUND OF HIGH FIDELITY, by Robert Oakes Jordan and James Cunningham. Windsor Press, 200 E. Ontario St., Chicago 11, Ill. 6¾ x 9½ in. 208 pp. $3.95.

A clearly illustrated and detailed text on the mechanics of high-fidelity sound and its reproduction. Also a handbook and guide to the proper operation and maintenance of hi-fi equipment. All important aspects are covered in nine chapters which range from sound, through amplification, and speakers, to tape recording and microphones.—*LS*

THEORY AND APPLICATION OF FERRITES, by Ronald F. Soohoo. Prentice-Hall, Inc., Englewood Cliffs, N. J. 6 x 9 in. 280 pp. $9.
FERRITES, by J. Smit and H. P. I. Wijn. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. 6 x 9 in. 440 pp. $10.

Mr. Soohoo's book is a comprehensive self-study by junior physicists and engineers. It covers properties, measurements, effect, at and below microwaves. The author-physicist uses physical reasoning mainly and includes graphs, illustrations and problems. Part 1 discusses theory. Part 2 discusses applications, many of them in detail.

The Smit and Wijn work is written by two physicists at an intermediate level. It covers theory, characteristics and properties. Much of it is based on work done at Philips Research Labs in Holland. The four main sections are: theory, measurements, properties, polycrystalline ferrites. Explanations rely heavily on physical models.

BASIC CARRIER TELEPHONY, by David Talley. John F. Rider Publisher Inc., 116 W. 14 St., New York 11, N.Y. 6 x 9 in. 170 pp. $4.25.

Much of the miracle of modern telephony is based on the carrier method. This makes it possible to send messages simultaneously along the same wire pair in both directions. This topic may seen difficult to explain and understand, but this author makes it clear with the help of a pictured text. Each page, each idea is broken down and illustrated.

Modulation, sidebands, line characteristics are discussed. Formulas are

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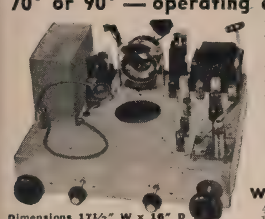
70° or 90° — operating all 17", 21", 24" and 27" PICTURE TUBES



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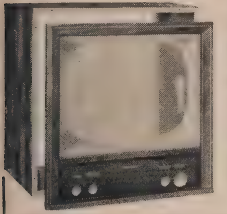

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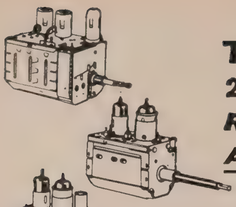

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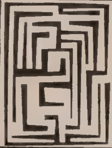

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◆

STEREO PREAMP CORRECTIONS

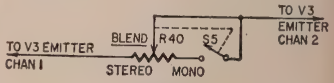
We received a number of inquiries requesting manufacturer's name and type number for the variable controls used in the Transistor Stereo Preamp in the December issue. Details have been supplied by Mr. Meyer.

The IRC parts used to make up the controls are as follows:

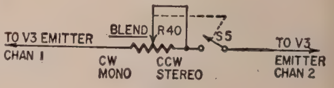
- Bass—1 ea KS-2 universal shaft kit
  - 1 ea K-5 Concentrikit
  - 2 ea B11-130 base element
- Treble—1 ea KS-2 universal shaft kit
  - 1 ea K-5 Concentrikit
  - 2 ea B11-116 base element (tap at 50% as per text)
- Volume—1 ea KS-2 universal shaft kit
  - 1 ea K-5 Concentrikit
  - 2 ea B13-116 base element
  - 1 ea 76-1 switch
- Balance—1 ea KS-2 universal shaft kit
  - 1 ea K-5 Concentrikit
  - 2 ea B11-110 base element
- Blend—1 ea Q11-123 control
  - 1 ea 76-1 switch

The circuit of the BLEND control and MONO-STEREO switch is incorrect on the main schematic diagram. The correct circuit is shown here.

Capacitors C9, C10, C11 and C12 were mistakenly identified as mica types. They may be high-quality paper, metallized paper, Mylar or metallized Mylar. These same general types may be used for C13, C17 and C18.



INCORRECT



CORRECT

The rectifiers in the full-wave bridge 18-volt power supply in Fig. 10 are 1N1440's, not 2N1440's as in the schematic.

There is only one 100-μf bypass capacitor across the preamp power line. C5 and C28 are shown on the diagram. Only C28 is shown on the printed-circuit board, so it is best to simply omit C5.

Mr. Meyer suggests making R10 and R11 100,000 and 270,000 ohms, respectively, to improve signal-handling capacity and temperature stability.

NOTEWORTHY CIRCUITS

SQUARING CIRCUIT

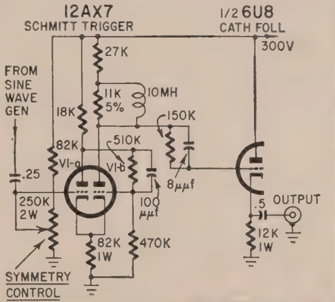
Here is a simple trigger circuit that can be used to convert an audio sine-wave or other waveform generator into a square-wave generator. The square-wave rise and fall times are less than 2 μsec. A cathode follower with low output impedance isolates the load from the trigger.

A most useful feature of the circuit is a variable-duty-cycle control over the output—the output waveform can be made rectangular rather than square with on-to-off or off-to-on ratios variable between 15% and 85%. This feature is invaluable in developing pulse-width and rate discriminators and for remote controlling timing operations.

The squaring circuit is a Schmitt trigger. Normally the right half of the 12AX7 (V1-b) is conducting, since its grid is tied to B+ through the 510,000- and 18,000-ohm resistors. V1-a is held cut off by the bias developed across the 82,000-ohm cathode resistor due to the plate current of V1-b. This condition establishes the lower level of output voltage at the plate of V1-b.

As the input signal swings positive, a point will be reached where V1-a starts to conduct. The falling plate voltage of V1-a causes the grid of V1-b to swing in a negative direction, cutting V1-b off. When V1-b cuts off, its plate rises to the value of the B-supply and establishes the upper output level. So long as the input voltage is above the level that caused conduction to switch from V1-b to V1-a the output is at the up level. When the input drops to a value slightly below this level, V1-a doesn't conduct hard enough to hold V1-b off, in which case V1-b switches full on, cutting V1-a off. The level the input must reach to cause switching is determined by the setting of the 250,000-ohm SYMMETRY CONTROL.

The cathode-follower output stage uses the triode half of a 6U8. This leaves the pentode half to be used as



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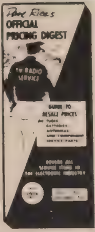

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FOR SALE — INFRA-RED SNOOPERSCOPES!! Optics, Lamps, Parts. World's largest stock Infra-red components. Write for FREE Infra-red Catalog. McNEAL ELECTRIC & EQUIPMENT, Dept. RE-4, 4736 Olive, St. Louis 8, Mo.

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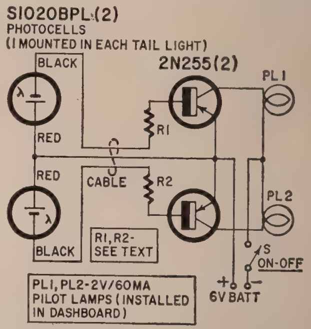
an oscillator or to replace the 6SJ7 used in many Wien Bridge oscillators. The 8-$\mu\mu f$ capacitor and 150,000-ohm resistor directly couple the trigger to the cathode follower to preserve low-frequency response. The circuit will operate from 20 to 20,000 cycles and can readily be installed in existing equipment as it draws negligible power.—*P. Cutler*

AUTO TAIL-LIGHT MONITOR

It is an easy matter for a driver to know when his headlights are out; failure of even one light is readily visible from the driver's seat. But taillights are a different matter. It is hard to know that one of these is out unless you go around back or unless someone tells you. But this weighs not at all with policemen in some large cities, like Los Angeles, where they give a ticket without warning when taillights die.

This circuit provides a constant monitoring scheme for both taillights. As long as the lights are in operation, pilot bulbs PL1 and PL2 glow on the dashboard. When either light fails, the corresponding pilot bulb goes out. This alerts the driver and allows him to take action before he receives a ticket.



A small, wafer type Silicon photocell (International Rectifier S1020BPL) is mounted inside each taillight. The active surface of the cell is turned toward the inside so as to receive light from the taillight bulb rather than from the highway behind the car. Each cell delivers a constant dc output as long as the taillight bulb is lighted, and drives an inexpensive 2N255 power transistor. Each transistor output actuates a 2-volt 60-ma pilot lamp mounted on the dashboard. The ON–OFF switch, S, may be combined with the regular light switch of the car so that the monitor will be turned on automatically with the car lights.

Resistors R1 and R2 limit the transistor dc signal input current to prevent burnout of the pilot lamps. In some cars having relatively dim taillights, these resistors will not be required. In others where taillights are unusually bright, R1 and R2 each will be 100 ohms or more (1 watt) and should be adjusted for full (but not excessive) brilliance of the pilot bulbs when the taillights are on.

The circuit may be adapted for 12-volt operation by connecting a 100-ohm 2-watt resistor in series with the positive dc lead.—*Rufus P. Turner* END

BUSINESS and PEOPLE

B & K Manufacturing Co., Chicago, jointly sponsored a service technicians' seminar in Chicago with Nationwide W-J, electronic distributors. Part of the overflow crowd of more than 400 is shown watching the highlight of the evening, a working demonstration of the Television Analyst.

Jensen Manufacturing Co., Chicago, is offering its high-fidelity dealers a custom made display/demonstration model TF-3 loudspeaker system at a special promotional price. The grille cloth has been removed and a gum-hardwood front baffle installed and silk-screened with price, finish, and component information.

Henry F. Callahan was elected a senior vice president of Sylvania Electric Products Inc. He will assume full responsibility for operations of the Lighting Products Div., Salem, Mass. He had been vice president and general manager of the division and has been with Sylvania for over 37 years. He succeeds **Frank J. Healy,** director and senior vice president of Sylvania, who continues to be responsible for the Semiconductor Div. operations and will assist president Robert E. Lewis in high-level corporate and interdivisional activities.

William H. Rous was appointed vice president of International Operations of the Amphenol-Borg Electronics Corp., Broadview, Ill. He will be in charge of developing international business. He continues to serve as vice president for marketing. Mr. Rous has been with Amphenol-Borg since 1941 and is a di-

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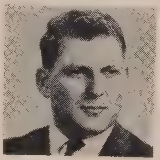
rector of the parent company and of several foreign subsidiaries.

Charles R. Billman was appointed vice president of manufacturing of Simpson Electric Co. of Chicago. He joined the firm from H. K. Porter Co., where he was assistant to the president and general manager of National Electric Div.

Donald H. Hartmann joined Heath Co., Benton Harbor, Mich., as executive vice president. He had been vice president and general manager of Moto-Mower, Inc. Prior to that he held executive positions with General Motors, Kaiser-Fraser Corp. and Packard Motor Car Co.

Harold J. Schulman has been named vice president and general manager of Knight Electronics Corp., wholly owned subsidiary of Allied Radio of Chicago. He was formerly marketing manager for sound products and Knight-Kits at Allied. He was chairman of the EIA committee which developed the first technical training course for service technicians.

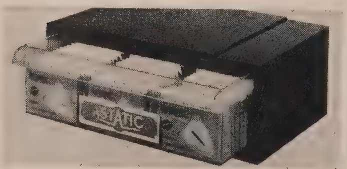


John Spitzer was promoted to manager of Advertising and Sales Promotion for the Sylvania Semiconductor Div., Woburn, Mass. He joined the company last year as advertising supervisor for the division.

Hal Dennis has joined United Audio Products, New York, as national sales manager. He had been sales director for Westminster Records.

Aerovox Corp., New Bedford, Mass. is packaging a selection of 18 of its miniature PTT-PWE electrolytic capacitors in reusable plastic boxes. The selection will cover 90% of the replacement needs for personal transistor radios and personal portable TV sets.

Astatic Corp., Conneaut, Ohio, has worked out a complete needle stocking and merchandising center for its dealers. The attractive ebony and red cabi-



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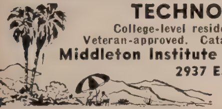

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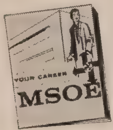

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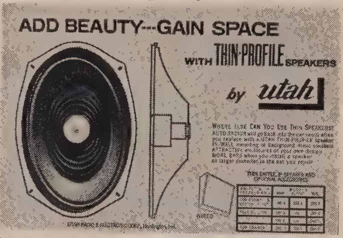
The Finney Co., Bedford, Ohio, and Tung-Sol Electric, Inc., Newark, N. J., cooperated with Radio Supply Co. of Wichita, Kans., in a three-way promotion among service technicians throughout the state. Top prize, a specially designed Volkswagen Transporter truck, was won by Earl Ehling and Forrest Wyckoff, partners in Ehling Radio & TV Service, Winfield, Kans.

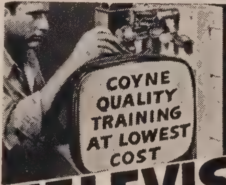
FINCO
TELEVISION ANTENNAS

Utah Radio & Electronic Corp., Huntington, Ind., designed a die-cut counter display which mounts an inverted speaker so that the front-mounted magnet structure can be plainly seen.



Audio Devices, Inc., New York, has broken ground for a new building for its expanding Research and Development, and Engineering departments at Stamford, Conn. Edwin J. Deadrick, plant manager; Dr. Orland O. Schaus, manager of research and engineering; president William T. Hack, and chairman William C. Speed (left to right) are shown as the ground-breaking begins.

Raytheon Co.'s Distributor Products Div., Westwood, Mass., has established a new record-keeping and business management service for TV and radio service technicians. Simplified Tax Records, Inc., a small business and tax advisory service, will work directly with each subscribing service technician and help him keep track of sales and expenses and will assist him in making out income-tax returns at the end of the year. The cost of the program is being shared by Raytheon, its distributors and subscribing technicians. END



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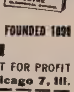

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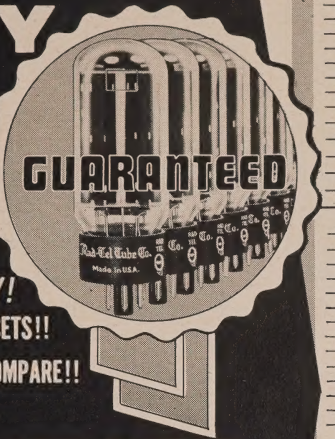

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___	1B3GT	.79	___	6AX7	.64	___	12AL5	.45
___	1DN5	.55	___	6BA6	.49	___	12AL8	.95
___	1G3	.73	___	6BC5	.54	___	12AQ5	.52
___	1J3	.73	___	6BC7	.94	___	12AT6	.43
___	1K3	.73	___	6BC8	.97	___	12AT7	.76
___	1L6	1.05	___	6BD6	.51	___	12AU6	.50
___	1LN5	.59	___	6BE6	.55	___	12AU7	.60
___	1R5	.62	___	6BF6	.44	___	12AV5	.97
___	1S5	.51	___	6BG6	1.66	___	12AV6	.41
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___	1U4	.57	___	6BH8	.87	___	12AX4	.67
___	1U5	.50	___	6BJ6	.62	___	12AX7	.63
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___	2AF4	.96	___	6BL7	1.00	___	12B4	.63
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___	5U4	.60	___	6U8	.78	___	17L6	.58
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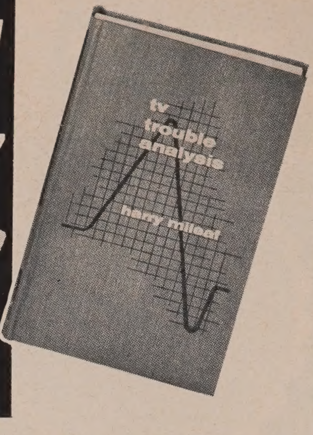

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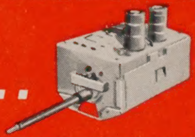

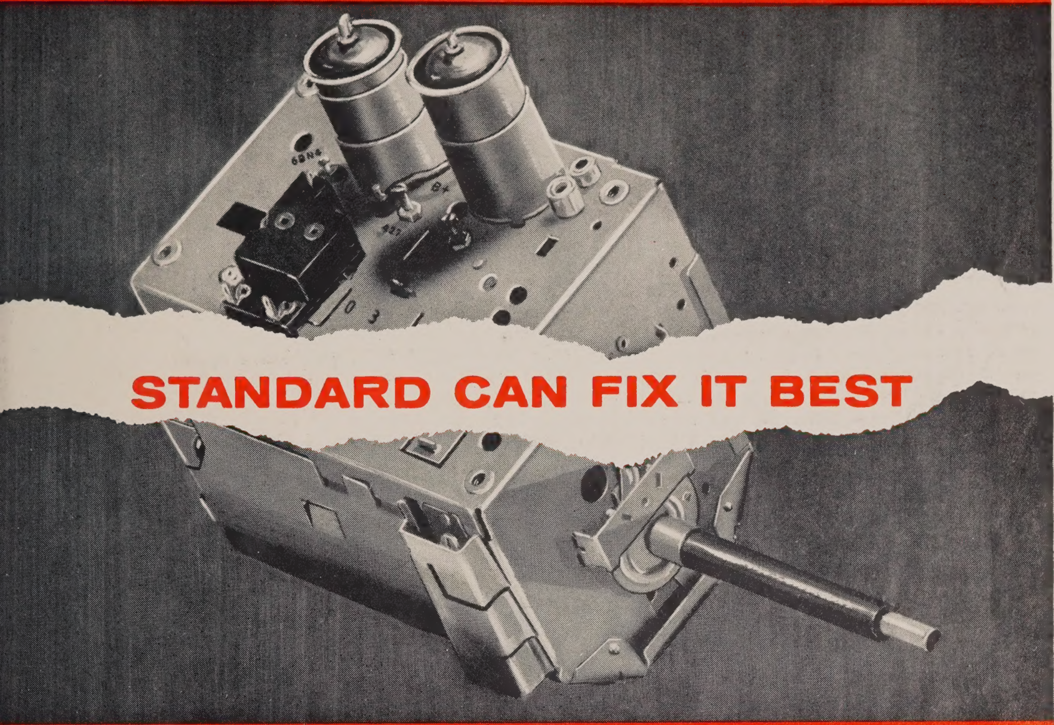

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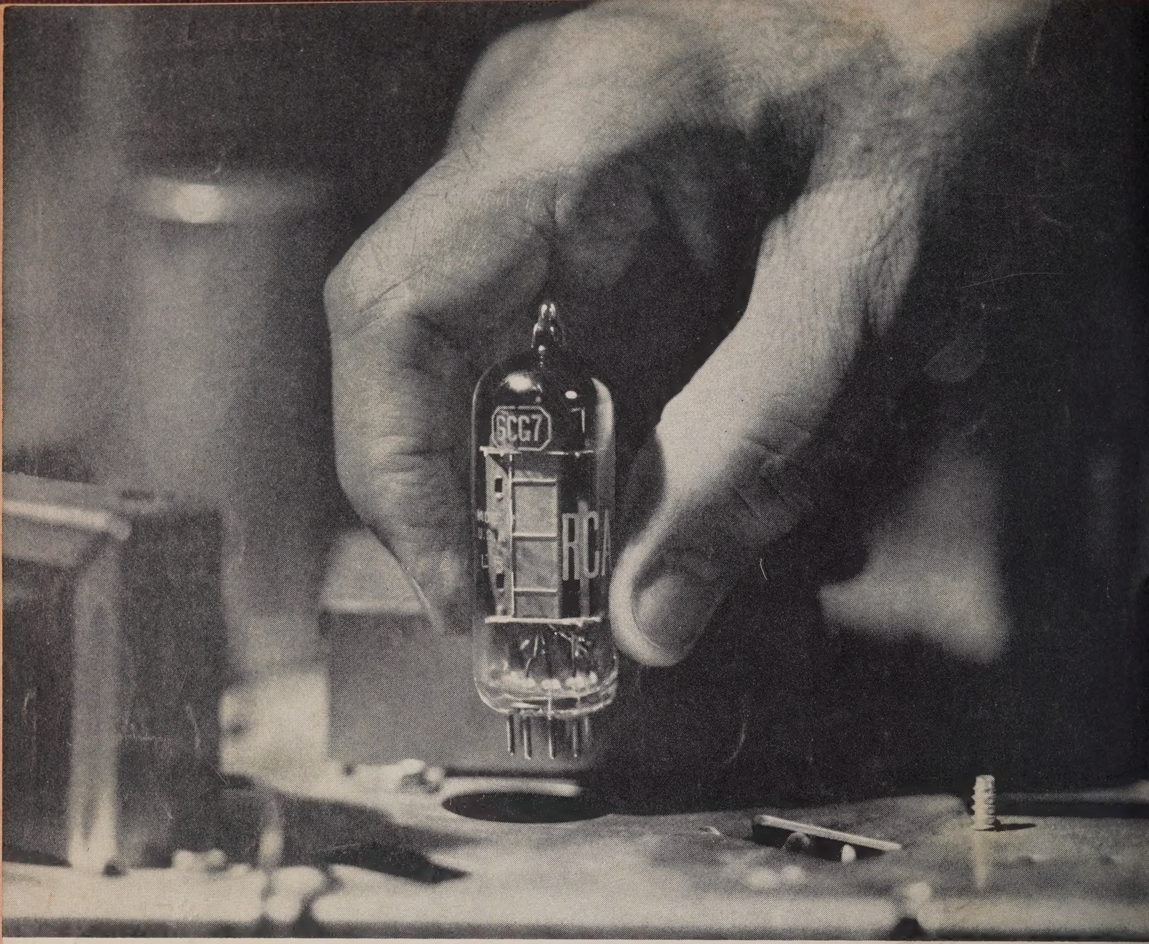

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